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SYNOPSIS OF THE FAMILIES OF VERTEBRATA.

BY E. D. COPE.

IN the following pages the attempt is made to bring together the information which we possess as to the characters of the divisions of the Vertebrata above families which are available for the determination of their relations by the paleontologist. These characters must be of the first importance to the discovery of the phylogenies, since the soft parts are unavailable. It is, however, true that the relations of these to the hard parts are close enough to render our inferences from the latter generally safe. Fortunately, also, the living remnants of extinct groups are sufficiently numerous to enable us to check our studies of the osteology. Thus we have the Branchiostoma, the lampreys, the Ceratodus and Lepidosiren, the Sphenodon, and the Monotremata, to which to refer when we desire to learn approximately the characters of the soft anatomy of ancient forms.

All the characters of the various divisions are not given. In fact, when all extinct forms come to be known, no division is likely to be defined by more than one character. At present several characters may be often ascribed to various divisions, but one of these will ultimately prove to be the essential one. It is the object of the present synopsis to bring these definitive characters into prominence; hence they are always stated first. The method of keys is adopted as the most perspicuous method of exhibiting them.

We are embarrassed in the endeavor to present the relations of the earliest and lowest Vertebrata by a want of knowledge of their

structure, and by the absence from our collections of numerous intermediate forms which must have existed. Until our knowledge is more complete the arrangement, especially of the contents of the class Agnatha, must be regarded as largely provisional.

The ossification of the skeleton of the Vertebrata has developed first on the exterior of the head and body, and in the sheath of the chorda dorsalis, and has then penetrated inwards. The limbs have preceded in time the arches (scapular and pelvic) to which they are, in the higher forms, attached. Hence we find in such genera as Cephalaspis and Bothriolepis, pectoral limbs without a scapular arch, but with merely dermal ossifications to which they are attached. This is parallel to the general absence of pelvic arch in most fishes. The limbs themselves are supposed to be radial ossifications in primitive longitudinal folds of the body integument, some of which remain in large part, as the dorsal fin of various fishes; while more frequently but few of the radii remain, as in the limbs of most Vertebrata.

The branch Vertebrata is divided into the following superclasses:

No skull nor skeleton; notochord short, anterior, temporary; nervous center a longitudinal cord; *Hemichorda.*

No skull nor skeleton; notochord caudal only; nervous center a ganglion; *Urochorda.*

No skull; notochord extending throughout the body, included in a membranous sheath, as is the cord-like nervous axis above it; *Cephalochorda.*

A cartilaginous or bony skull and skeleton, which extends throughout the body; central nervous system a longitudinal cord terminating in a brain within the skull; *Craniata.*

HEMICHORDA.

There is but one class of Hemichorda.

Not metameric; no mantel; respiratory fissures on each side of the pharynx; alimentary canal with openings at opposite extremities of body; *Enteropneusta.*

ENTEROPNEUSTA.

But one order of this class is yet known.

No appendages to the body except an oval mass extending in front of the head; *Helminthophya.*

The order HELMINTHOPHYA embraces but one family, the Balanoglossidæ.

UROCHORDA.

There is but one class of Urochorda; viz.:

Not metameric; a mantel covering the body; respiration pharyngeal; heart distinct, saccular; *Tunicata.*

TUNICATA.

There are two orders of Tunicata.

Inhalent and exhalent openings close together; alimentary canal elongate; *Ascidiæ.*

Inhalent orifice and anus at opposite extremities; alimentary canal crowded into a body termed a nucleus; *Thaliacea.*

To the ASCIDIÆ belong the families Appendiculariidæ, Clavellinidæ, Ascidiidæ, Botryllidæ, Didemnidæ, Polyclinidæ, and Pyrosomidæ. To the THALIACEA are referred the families Salpidæ and Doliolidæ.

CEPHALOCHORDA.

The only class of the Cephalochorda is the following:

No mantel; walls of the body muscular myotomes; no jaws nor extremities; pharyngeal walls fissured; heart a longitudinal vessel, which gives off branchial vessels, which unite into an aorta; a liver and vena cava present; *Acrania.*

Of the class *ACRANIA* but one order as yet know.

Pharyngeal fissures enclosed externally by a fold of the integument, which encloses a chamber (atrium) which opens inferiorly; openings of alimentary canal at opposite extremities; heart tubular; *Leptocardii.*

The only family of the LEPTOCARDII is the Branchiostomidæ.

CRANIATA.

I. No lower jaw nor pectoral arch.

Internal skeleton not ossified; *Agnatha.*

II. Lower jaw and pectoral arch present.

a. Basicranial axis not ossified; vertebral column consisting chiefly of intercentra.

Limbs represented by many-radiate fins, which are also present on the median lines of the body; a coracoid bone; heart with two chambers; no internal nares; *Pisces.*

Limbs consisting of one basal element, two propodials, and metapodials and digits; no median fins; no opercular bones; a coracoid; heart with three chambers; two occipital condyles; internal nares; *Batrachia.*

aa. Basicranial axis ossified; vertebral column consisting chiefly of centra. An amnion and allantois.

Limbs as in Batrachia; one occipital condyle; a suspensorium of the lower jaw; mandible segmented; heart with three chambers; *Monocondylia.*

Limbs as in Batrachia; two occipital condyles; no suspensorium of the lower jaw; mandible not segmented; heart with four chambers; *Mammalia.*

AGNATHA.

The known members of the class AGNATHA are a very small representation of those that once existed; and they present a great variety of character, having little affinity with each other. Two sub-classes are most distinctly indicated.

An osseous dermal skeleton with lateral limb-like appendages; *Ostracodermi.*

No osseous skeleton, nor lateral limb-like appendages; *Marsipobranchii.*

OSTRACODERMI.

The orders of this division are two.

Orbits well separated; no nostrils; *Arrhina.*

Orbits separated by a plate which is pierced by two orifices, possibly nostrils; *Diplorrhina.*

To the ARRHINA belong the families of the Pteraspididæ and Cephalaspidæ, and to the DIPLORRHINA that of the Mycteropidæ. The latter has some affinity to the Pterichthyidæ, which has similarly approximated orbits, or orifices which correspond with those provisionally termed orbits in Mycterops. They are separated in the Pterichythidæ by a movable plate which is not perforated. Pterichythidæ differ in the possession of a peculiar dorsal shield, which resembles that of the Tunicate germs Chelyosoma. The tail, present in Pterichthys, is wanting in Bothriolepis, calling to mind the absorption of the tail in the Tunicates. The lateral appendages resemble, those of the Tunicate genus Appendicularia. For the above reasons I have placed the Pterichyidæ in the Tunicata, as the type of a distinct order, the Antiarcha. This order may belong to the Ostracodermi.

MARSIPOBRANCHII.

This subclass has two orders.

Branchial fissures communicating directly with the pharynx; nasal sac perforating the palate; *Hyperotreti.*

Branchial fissures communicating with a common branchial passage which opens into the pharynx; nasal sac not perforating palate; *Hyperoarti.*

To the HYPEROTRETI belong two families, the Myxinidæ and the Bdellostomidæ; to the HYPEROARTI one, the Petromyzontidæ.

PISCES.

This class is divided into four subclasses.

I. No suspensorium of the mandible.

No dermal cranial ossifications; ventral claspers; no opercular bones; no maxillary arch; *Holocephali.*

Dermal cranial ossifications and opercular bones; no claspers; no maxillary arch; *Dipnoi.*

II. A suspensorium of the mandible.

No dermal cranial ossifications nor opercular bones; claspers present; *Elasmobranchii.*

Dermal cranial ossifications and opercular bones; no claspers; a maxillary arch; *Teleostomi.*

HOLOCEPHALI.

But one order of this subclass known.

A single external branchial fissure; actinotrichia present; basilars, axonosts and neural spines articulating with each other; pectoral fin with three axonosts and numerous basilars; ventrals with elongate axonosts and basilars; *Chimæroidei.*

The order CHIMÆROIDEI embraces only the family Chimæridæ.

DIPNOI.

There is but one order of this subclass known as yet.

Actinotrichia; baseosts and axonosts of median fins continuous with neural spines; paired fins with a single basal axonost and numerous segments continuous with it; swim-bladder cellular; *Sirenoidei.*

Three families represent our knowledge of the order SIRENOIDEI; the Dipteridæ, the Ceratodontidæ, and the Lepidosirenidæ.

ELASMOBRANCHII.

There are two orders of this subclass.

A basioccipital and exoccipital elements; actinotrichia; baseosts and axonosts continuous with neural spines; paired fins with a single basal axonost, and numerous others in line with it; claspers simple; *Ichthyotomi.*

No basi or exoccipital; median baseosts and axonosts continuous with vertebral spines; several axonosts to paired fins, and numerous baseosts; claspers complex; actinotrichia; *Selachii.*

To the order ICHTHYOTOMI belong the families Xenacanthidæ and Cladodontidæ. To the SELACHII belong the following: (*Squali,*) Psammodontidæ, Petalodontidæ, Cochliodontidæ, Cestra-

ciontidæ, Spinacidæ, Notidanidæ, Lamnidæ, Carchariidæ, Squatinidæ, Rhinobatidæ, Pristiophoridæ; (*Rajæ*,) Pristidæ, Squatinorajidæ, Rajidæ, Trygonidæ, Myliobatidæ.

TELEOSTOMI.

There are four superorders of this subclass, which are distinguished by the fins.

Dorsal, anal, pectoral, and ventral axonosts present, represented by a single element to each fin; *Rhipidopterygia.*

Dorsal, anal, pectoral, and ventral axonosts present, the dorsal and anal numerous, the pectoral in variable number, articulating with numerous well-developed baseosts; the ventral axonost single, with numerous baseosts; *Crossopterygia.*

Dorsal and anal exonosts as in the last; no pectoral exonost; pectoral and ventral baseosts elongate, numerous; *Podopterygia.*

Dorsal and anal axonosts present; no pectoral axonost; pectoral baseosts few and small; ventral baseosts rudimental; dorsal, and generally anal baseosts rudimental or wanting; axonosts not corresponding with neural spines; *Actinopterygia.*

RHIPIDOPTERYGIA.

Two orders of this superorder are known

Basseosts present in dorsal and anal fins; pectoral fin? *Rhipidistia.*

Basseosts wanting to dorsal and anal fins; caudal axonosts present, each one articulating with a neural spine; pectoral fin? *Actinistia.*

To the RHIPIDISTIA belongs the single family of the Tristichopteridæ; and to the ACTINISTIA the Cœlacanthidæ.

CROSSOPTERYGIA.

I. Dorsal baseosts present; pectoral axonosts uniserial.

Pectoral fins a simple axis, when present; body with dorsal and ventral shields; axonosts articulating with neural spines; [1]*Placodermi.*

Actinotrichia present; axonosts articulating with neural spines; *Haplistia.*

Median fin radii equal in number and articulating with baseosts; *Taxistia.*

II. No dorsal baseosts (or rudiments only); pectoral axonosts triserial.

Median fin radii equal to and articulating with baseosts; axonosts not articulating with neural spines; *Cladistia.*

The PLACODERMI includes the families of the Coccosteidæ, and Dinichthyidæ.

The Phaneropleuridæ is the only known family of the HAPLISTIA; while two are known to belong to the TAXISTIA, viz., the Holoptychiidæ and the Osteolepididæ. To the CLADISTIA belongs only the existing family of the Polypteridæ.

PODOPTERYGIA.

One order of this superorder is known.

Median fins with actinotrichia, and with baseosts and axonosts corresponding with each other and with neural spines; scapular arch suspended to cranium by a post-temporal element; a precoracoid arch and interclavicles; no preoperculum nor symplectic; a notochord; *Chondrostei.*

To the order CHONDROSTEI belong three families, the Polyodontidæ and Accipenseridæ without, and the Chondrosteidæ with, branchiostegal radii.

ACTINOPTERYGIA.

Two tribes pertain to this superorder.

Ventral fins abdominal; a ductus pneumaticus; no spinous dorsal fin; parietal bones usually in contact; scales usually cycloid; *Physostomi.*

[1] The position of this order is not yet certain.

Ventral fins usually thoracic or jugular; no ductus pneumaticus; usually a spinous dorsal fin; parietal bones usually separated by the supraoccipital; scales usually ctenoid; *Physoclysti.*

PHYSOSTOMI.

I. Median fin rays with actinotrichia.

Intercentra distinct, small; no centra. [2]*Lysopteri.*

II. Median fin rays equal to and articulating with axonosts.

α, Vertebræ complex, the pleurocentra and intercentra distinct.

Anterior vertebræ similar; *Merospondyli.*

αα, Vertebræ with centra and intercentra both complete on part of the column at least; amphicœlous;

Anterior vertebræ similar; *Halecomorphi.*

ααα, Vertebræ (intercentra) opisthocœlous.

Anterior vertebræ similar; a precoracoid arch and a coronoid bone; *Ginglymodi.*

αααα, Vertebræ (intercentra) amphicœlous.

β A, Precoracoid arch.

γ, No symplectic bone.

Pterotic simple; anterior vertebræ modified, and with ossicula auditus; parietals not distinct; *Nematognathi.*

Pterotic annular, including a cavity which is closed by a distinct bone; anterior vertebræ simple, without ossicula auditus; parietals distinct; *Scyphophori.*

γ γ, A symplectic bone.

Anterior vertebræ coössified and with ossicula auditus; pterotic simple; *Plectospondyli.*

Anterior vertebræ not modified; pterotic simple; parietals distinct; *Isospondyli.*

β β, No precoracoid arch.

γ, Scapular arch suspended to cranium.

δ, A symplectic.

Anterior vertebræ and pterotic simple; parietals separated by supraoccipital; *Haplomi.*

Anterior vertebræ modified; parietals not separated; *Glanencheli.*

[2] This order may belong to the Prodopterygia.

$\delta\delta$. No symplectic.

Anterior vertebræ simple; a preoperculum and palatine arch; *Ichthyocephali.*

$\gamma\gamma$. Scapular arch free from cranium.

δ. A symplectic bone.

Hyoid arches developed; *Holostomi.*

$\delta\delta$. No symplectic.

Opercular bones and five osseous branchial arches, with ceratohyal; *Enchelycephali.*

Opercular bones, and one osseous branchial arch, ceratohyal; *Colocephali.*

No opercular bones, nor ceratohyal, nor osseous branchial arches; *Lyomeri.*

The families of the Physostomi are as follows:

LYSOPTERI; Palæoniscidæ.

MEROSPONDYLI; Sauropsidæ; Pycnodontidæ; Stylodontidæ; Sphærodontidæ; Macrosemiidæ.

HALECOMORPHI; Amiidæ.

GINGLYMODI; Lepidosteidæ.

ISOSPONDYLI; Dapediidæ; Lepidotidæ; Aspidorhynchidæ; Saurodontidæ; Osteoglossidæ; Heterotidæ; Galaxiidæ; Clupeidæ; Chirocentridæ; Salmonidæ; Thymallidæ; Alepocephalidæ; Gonorhynchidæ; Sauridæ; Lutodiridæ; Aulopidæ; Elopidæ; Albulidæ; Hyodontidæ; Notopteridæ.

ACTINOCHIRI; Pelecopteridæ.

PLECTOSPONDYLI; Characinidæ; Sternopygidæ; Cobitidæ; Cyprinidæ; Catostomidæ.

SCYPHOPHORI; Mormyridæ; Gymnarchidæ.

NEMATOGNATHI; Siluridæ; Hypophthalmidæ; Aspredinidæ.

HAPLOMI; Esocidæ; Stratodontidæ; Umbridæ; Cyprinodontidæ; Amblyopsidæ.

GLANENCHELI; Gymnotidæ.

ICHTHYOCEPHALI; Monopteridæ.

HOLOSTOMI; Symbranchidæ.

ENCHELYCEPHALI; Nemichthyidæ; Anguillidæ; Congridæ.

COLOCEPHALI; Murænidæ.

LYOMERI; Saccopharyngidæ; Eurypharyngidæ.

PHYSOCLYSTI.

I. Basilar bones of median fins well developed;

Scapular arch suspended to cranium; pectoral fin with numerous basilar bones; *Docopteri.*

II. Basilar bones of median fins rudimental or wanting. Pectoral basilars few.

A. Scapular arch suspended to the anterior vertebræ.

Maxillary bone distinct; no interclavicles; epibranchials and pharyngeals present; inferior elements distinct; *Opsithomi.*

AA. scapular arch suspended to cranium by a posttemporal bone.

a. Ventral fins abdominal.

Branchial arches developed, third superior pharyngeal enlarged; gill fringes linear; no interclavicles; *Percesoces.*

Epibranchials and superior pharyngeals reduced in number; interclavicles; gill-fringes linear; *Hemibranchii.*

Epibranchials and superior pharyngeals wanting; gill fringes in tufts; *Lophobranchii.*

aa. Ventral fins thoracic or jugular.

β. Anterior (spinous) dorsal fin expanded into transverse laminæ sessile on cranium.

Cranium normal; branchial bones present; *Discocephali.*

$\beta\beta$. Spinous dorsal fin not traversely expanded.

γ. Posttemporal projecting freely from skull.

First vertebra united by suture to cranium; intercalaria united behind supraoccipital; basilar pectoral bones elongated; *Pediculati.*

Posterior cephalic region normal; the anterior twisted so as to bring both orbits on one side; inferior pharyngeals distinct *Heterosomata.*

Cranium normal, premaxillaries usually coössified with maxillaries behind, and the dentary with the articular; pharyngeal bones distinct; *Plectognathi.*

Cranium normal; bones of jaws and pharyngeals distinct; *Percomorphi.*

Cranium normal, bones of jaws distinct; third superior pharyngeal much enlarged and articulated with cranium; inferior pharyngeals coösified; *Pharyngognathi.*

$\gamma\gamma$. Posttemporal an integral part of the skull.

Cranium normal; bones of jaws distinct; pharyngeals separate; *Craniomi.*

The families of the preceding order are the following:

Docopteri; Dorypteridæ (possibly Physostomous.)

Opisthomi; Mastacembelidæ; Notacanthidæ.

Percesoces; Opheocephalidæ; Mugilidæ; Atherinidæ; Sphyraenidæ; Scombresocidæ.

Hemibranchii; Pegasidæ; Gasterosteidæ; Fistulariidæ; Centriscidæ; Amphisilidæ; Dercetidæ.

Lophobranchii; Solenostomidæ; Syngnathidæ; Hippocampidæ.

Discocephali; Echeneididæ.

Pediculati; Antennariidæ; Lophiidæ.

Heterosomata; Pleuronectidæ.

Plectognathi; Triacanthidæ; Balistidæ; Tetrodontidæ; Diodontidæ; Ostraciidæ.

Percomorphi; (Anacanthini) Ophidiidæ; Gadidæ; Macruridæ; (Haplodoci) Batrachidæ; (Cyclopteroidea) Cyclopteridæ; (Epilasmia) Acroneuridæ, Chætodontidæ; (Distegi) Scorpænidæ; Cottidæ; Blenniidæ; Gobiidæ; Platycephalidæ; Rhamphocottidæ; Agonidæ; Heterognathidæ; Gerreidæ; Carangidæ; Sillaginidæ; Pristipomatidæ; Scienidæ; Sparidæ; Percidæ; Berycidæ; Scombridæ; Trichiuridæ; Xiphiadidæ; (Labyrinthici) Osphromenidæ; Anabantidæ.

Pharyngognathi; Embiotocidæ; Cichlidæ; Labridæ; Scaridæ.

Craniomi; Triglidæ; Dactylopteridæ.

BATRACHIA.

The eight orders of the class Batrachia are defined as follows:

I. Basioccipital, supraoccipital, intercalary and supratemporal bones present; propodial bones distinct (*Stegocephali*).

a. One occipital cotyloid articulation.

Vertebral bodies represented by basal and lateral elements (intercentra and centra); *Ganocephali.*

aa. Two occipital condyles.

Vertebræ represented by distinct and incomplete intercentra and centra (pleurocentra); atlas segmented; *Rhachitomi.*

Centra and intercentra complete, making two vertebral bodies to each neural arch; *Embolomeri.*

No centra; intercentra, each supporting a neural arch; *Microsauri.*

II. Basioccipital, supraoccipital, and supratemporal bones wanting; propodial bones distinct; no urostyle (*Urodela*).

a. An os intercalare.

Palatine arch and vomer present; *Proteida.*

aa. No os intercalare.

A maxillary arch and vomers; *Pseudosauria.*

No maxillary arch or vomers; *Trachystomata.*

III. Basioccipital, supraoccipital, intercalare, and supratemporals wanting; frontals and parietals connate; propodial bones connate; lumbosacral vertebrae united into a urostyle (*Salientia*).

A palatine arch and vomers; *Anura.*

STEGOCEPHALI.

Of the GANOCEPHALI two families are known, the Trimerorhachidæ without, and the Archegosauridæ with neural spines of the vertebræ.

The RHACHITOMI possess but one family, the Eryopidæ. To this family belongs the Labyrinthodontia.

Of the EMBOLOMERI one family is known, the Cricotidæ.

The MICROSAURI embraces the following families; Branchiosauridæ; Hylonomidæ; Molgophidæ; Phlegthontiidæ.

URODELA.

Under the PROTEIDA the only family known is the Proteïdæ.

The PSEUDOSAURIA embraces the following families: Crypto-

chidæ; Amblystomidæ; Hynobiidæ; Plethodontidæ; Thoriidæ; Desmognathidæ; Salamandridæ; Pleurodelidæ; Amphiumidæ; Caeciliidæ.

The TRACHYSTOMATA includes only the family of the Sirenidæ.

SALIENTIA.

The ANURA has the families arranged under the following suborders:

Internal nostrils opening together on the middle line; no tongue; coracoids connected by a cartilage on each side; *Aglossa.*

Internal nostrils separate; a tongue; coracoids connected by a separate cartilage on each side; *Arcifera.*

Internal nostrils separate; a tongue; a single median cartilage connecting all the coracoids; scapular arch free; *Firmisternia.*

As in Firmisternia, but scapular arch articulated to skull; *Gastrechmia.*

(Aglossa): Xenopidæ; Pipidæ.

(Arcifera): Discoglossidæ; Bufonidæ; Dendrophryniscidæ; Asterophydidæ; Pelodytidæ; Scaphiopidæ; Hylidæ; Cystignathidæ; Amphignathodontidæ; Hemiphractidæ.

(Gastrechmia): Hemisidæ.

(Firmisternia): Engystomidæ; Phryniscidæ; Dendrobatidæ; Cophylidæ; Dyscophidæ; Colostethidæ; Ranidæ; Ceratobatrachidæ.

MONOCONDYLIA.

There are two subclasses of Monocondylia.

Anterior limbs ambulatory, with numerous carpal and metacarpal bones; two aorta roots; integument consisting partly of scales; *Reptilia.*

Anterior limbs volant, with the carpals and metacarpals more or less coössified and reduced in numbers; integument consisting in part of feathers; one aorta root; *Aves.*

REPTILIA.

Nine orders of Reptilia are known.

I. The quadrate bone united with the adjacent elements by suture.

A. Cranium with one postorbital bar.

a A paroccipital bone.

A supratemporal bone; ribs two-headed on centrum; carpals and tarsals not distinct in form from metapodials; *Ichthyopterygia.*

No supratemporal; sub- and post-pelvic ossifications; interclavicle and clavicles separated from and below scapular arch; ribs one-headed; coracoid large, free; *Testudinata.*

aa No paroccipital bone.

Ribs mostly two-headed, capitulum intercentral; clavicles and interclavicles forming part of shoulder-girdle; no sub- or post-pelvic bones; pelvic elements below plate-like, obturator foramen small or none; *Theromora.*

Ribs one-headed; scapula triradiate; no clavicles; coracoid large, distinct; no sub- or post-pelvic bones; *Plesiosauria.*

AA. Cranium with two postorbital bars.

a. No paroccipital bone; (no supratemporal).

Ribs two-headed; no interclavicle; external digits greatly elongate to support a patagium; *Ornithosauria.*

Ribs two-headed; no interclavicle; acetabulum perforate; feet ambulatory; no patagium; *Dinosauria.*

Ribs two-headed; an interclavicle; acetabulum closed; feet ambulatory; no postfrontal bone; *Crocodilia.*

Ribs one-headed; an interclavicle; acetabulum closed; feet ambulatory; *Rhynchocephalia.*

II. The quadrate bone loosely articulated with adjacent elements, and only proximally.

The quadrate bone in contact only with adjacent elements; no intercalare; supratemporal present; ribs one-headed; *Squamata*

The order ICHTHYOPTERYGIA embraces the families of Ichthyosauridæ and Mixosauridæ.

Two families enter the ORNITHOSAURIA, viz., the Pteranodontidæ and the Pterodactylidæ.

The DINOSAURIA embraces two suborders, as follows:

Inferior pelvic elements directed downwards; *Saurischia.*
Pelvic elements directed backwards; *Orthopoda.*

The families of the *Saurischia* are the Cetiosauridæ, Cœluridæ and Megalosauridæ. Those of the *Orthopoda* are the Agathaumidæ, Omosauridæ, Scelidosauridæ, and Iguanodontidæ.

The order CROCODILIA embraces one suborder, as follows:

Nareal canal underoofed to behind larynx; no epipterygoid, nor clavicle; pelvis excluded from acetabulum; *Eusuchia.*

Under the *Eusuchia* we know the families Crocodilidæ, Goniopholidæ, and Teleosauridæ.

The RHYNCHOCEPHALIA is a varied order. Its contents fall into two suborders:

Premaxillary region forming a toothless beak; ribs with uncinate process; *Sphenodontina.*
Premaxillary region not beaked; uncinate processes wanting; *Choristodera.*

To the *Sphenodontina* belongs the Sphenodontidæ. The Champsosauridæ from the suborder Choristodera, on account of their many peculiarities, the most important of which now known is the separation of the *os dentatum* from the axis.

The order TESTUDINATA presents four subordinal modifications, as follows:

I. No descending processes of the parietal bones.

Vertebræ and ribs free and separated from a bony exoskeleton; no descending processes of the parietals; *Athecæ.*

II. A carapace and plastron, and descending process of parietals.

a. Sacral and caudal ribs articulating with neural arches only.

Neck bending in vertical plane, last cervical articulating with first dorsal by zygapophyses only; pelvis not anchylosed; marginal bones wanting or rudimental; *Trionychoidea.*

aa. Sacral and caudal ribs articulating with body of vertebræ only.

As the last; but marginal bones present and connected with ribs, and last cervical and last dorsal vertebræ articulating by bodies; pelvis not anchylosed to plastron. *Cryptodira.*

Neck bending in horizontal plane, the last cervical and first dorsal vertebræ articulating by bodies; pelvis anchylosed to carapace and plastron; marginal bones present and connected with ribs; *Pleurodira.*

The *Athecæ* includes the single family of the Dermochelydæ.

The *Trionychoidea* includes only the Trionychidæ.

The *Cryptodira* embraces the Cheloniidæ, Testudinidæ, Cinosternidæ, Dermatemydidæ, Chelydridæ, Baënidæ and Adocidæ.

The *Pleurodira* includes the Pleurosternidæ, Sternothæridæ Pelomedusidæ, Plesiochelydidæ, Chelydidæ and Carettochelydidæ.

The order THEROMORA includes six suborders.

I. Palate closed except posteriorly.

A temporal foramen; *Placodontia.*

II. Palate open anteriorly for nares.

A. The coracoid bone large, reaching sternum.

Dentition abundant; pubis and ischium plate-like; ribs one-headed; *Proganosauria.*

Dentition abundant; ribs two-headed; *Parasuchia.*

Four or five sacral vertebræ; centra not notochordal; no intercentra; dentition imperfect or wanting; obturator foramen minute; *Anomodontia*

AA. The coracoid reduced, not reaching sternum.

Ribs two-headed; two or three sacral vertebræ;

centra generally notochordal; intercentra generally present; dentition abundant; *Pelycosauria.*

Ribs single-headed; temporal fossa overroofed; dentition abundant; intercentra; *Cotylosauria.*

The *Placodontia* include the Placodontidæ only. The *Parasuchia* include the Belodontidæ, and probably the Aëtosauridæ. The *Progansauria*, the Mesosauridæ, the Procolophonidæ, Palæohatteriidæ, Homœosauridæ, Proterosauridæ and Rhynchosauridæ. The *Cotylosauria* include the Pariasauridæ and the Diadectidæ.

The *Pelycosauria* embraces the families of the Clepsydropidæ, Pariotichidæ, and Bolosauridæ. The *Anomodontia* includes the single family of the Dicynodontidæ, and perhaps the Endothiodontidæ.

The PLESIOSAURIA embraces the following families: Plesiosauridæ, Nothosauridæ, and Lariosauridæ.

The SQUAMATA is an extended group, which is represented by three sub-orders, which are defined as follows:

Alisphenoid modified as epipterygoid, or wanting, leaving brain-case open; parietals flat; an interclavicle and clavicle; teeth with dentinal roots; *Lacertilia.*

Epipterygoid present; parietals decurved, partially enclosing brain-case; no clavicle nor interclavicle; teeth with osseous roots; *Pythonomorpha.*

No epipterygoid; brain-case enclosed in front; no clavicle nor interclavicle; no fore-limbs; *Ophidia.*

The LACERTILIA embraces the following superfamilies.

I. Proötic not produced beyond arched body; acrodont; olfactory lobes not underarched; two suspensoria.

No clavicle nor interclavicle; no columella; tongue papillose, extremity sheathed; *Rhiptoglossa.*

A clavicle proximally simple; an anchor-shaped interclavicle; a columella; tongue papillose, not sheathed; *Acrodonta.*

II. Proötic bone not produced beyond arched body; dentition pleurodont; olfactory lobes not underarched; two suspensoria.

A clavicle proximally simple; an anchor-shaped interclavicle; a columella; tongue papillose, not sheathed; *Iguania.*

III. Proötic bone not produced beyond arched body; dentition pleurodont, or nearly so; two suspensoria.

a. Clavicle simple proximally; olfactory lobes not underarched by frontal.

Interclavicle cruciform; tongue papillose; *Diploglossa.*

aa. Clavicle proximally simple; olfactory lobes underarched by frontal.

Vertebræ procœlous; tongue smooth; *Thecaglossa.*

Vertebræ amphicœlous; tongue papillose; *Geccovarani.*

aaa. Clavicle proximally expanded; olfactory lobes underarched by os frontale.

Tongue papillose or smooth; *Nyctisaura.*

aaaa. Clavicles, when present, expanded proximally; olfactory lobes not underarched.

Clavicles, interclavicle, and sternum present; surangular distinct; tongue scaly; *Leptoglossa.*

Clavicles, interclavical and sternum absent; tongue scaly; *Typhlophthalmi.*

IV. Proötic bone produced beyond arched body; one suspensorium (=supratemporal wanting); pelvic arch rudimentary or wanting.

Frontal bone underarching olfactory lobes; supraoccipital gomphosis internal; no orbitosphenoid; *Anguisauri.*

Frontal bone underarching olfactory lobes; supraoccipital gomphosis external; an orbitosphenoid; *Opheosauri.*

The families of these suborders are the following:

Rhiptoglossa; Chamæleonidæ.

Acrodonta; Agamidæ.

Iguania; Iguanidæ, Anolidæ.

Diploglossa; Zonuridæ, Pygopodidæ, Anguidæ, Xenosauridæ, Helodermidæ.

Thecaglossa; Varanidæ.

Geccovarani; Uroplatidæ.
Nyctisaura; Eublepharidæ, Gecconidæ.
Leptoglossa; Xantusiidæ, Teidæ, Lacertidæ, Gerrhosauridæ, Scincidæ.
Typhlophthalmi; Acontiidæ, Anelytropidæ.
Anguisauri; Aniellidæ.
Opheosauri; Chirotidæ, Amphisbænidæ, Trogonophidæ.

The PYTHONOMORPHA embraces two families, the Plioplatecarpidæ, and the Mosasauridæ.

The OPHIDIA include the following superfamilies.

A. Supratemporal intercalated in the cranial walls. (*Angiostomata.*)

a. No ectopterygoid; palatines bounding choanæ posteriorly; ethmoturbinal forming part of roof of mouth; rudiments of a pelvis. (*Scolecophidia.*)

Maxillary bone fixed to perfrontal and premaxillary; a pelvis; *Catodonta.*

Maxillary bone vertical and free from all others; no pelvis; *Epanodonta.*

aa. An ectopterygoid; palatines not bounding choanæ posteriorly.

Maxillary bone free, horizontal; *Tortricina.*

AA. Supratemporal attached scale-like to cranial walls, produced freely posteriorly; ectopterygoid present (*Eurystomata.*)

Maxillary bone horizontal, in contact with the premaxillary, and furnished with solid teeth; no rudiments of pelvis; *Asinea.*

Maxillary bone horizontal, thickened in front, and not reaching premaxillary, and bearing a perforate tooth; *Proteroglypha.*

Maxillary bone vertical, not reaching premaxillary, articulating with the prefrontal by a ginglymus, and to the ectopterygoid without imbrication, and bearing a perforated tooth; *Solenoglypha.*

The families embraced by these superfamilies are as follows:
Catodonta; Stenostomidæ.

Epanodonta ; Typhlopidæ.
Tortricina ; Tortricidæ, Uropeltidæ.
Asinea ; Xenopeltidæ, Pythonidæ, Boidæ, Charinidæ, Achrochordidæ, Nothopsidæ, Colubridæ.
Proteroglypha ; Hydrophidæ, Najidæ, Elapidæ, Dendraspididæ.
Solenoglypha ; Causidæ, Atractaspididæ, Viperidæ, Crotalidæ.

AVES.

There are four superorders of the birds, as follows :

Metacarpal and carpal bones all distinct, the digits with ungues ; caudal vertebræ numerous, unmodified ; clavicles united ; pelvic elements distinct ; teeth present ; *Saururæ.*

Metacarpals and carpals coössified ; digits without ungues ; caudal vertebræ moderately numerous, without ploughshare bone ; clavicles distinct ; pelvic elements coössified ; teeth present ; *Odontolcæ.*

Metacarpals and pelvic elements coössified ; caudal vertebræ reduced, with a pygostyle or plowshare bone ; vertebræ biconcave ; teeth present ; *Odontotormæ.*

Metacarpals and carpals coössified ; pelvic elements coössified ; clavicles coössified ; caudal vertebræ few, terminating in a plowshare bone ; vertebræ mostly saddle-shaped ; no teeth ; *Eurhipiduræ.*

The SAURURÆ includes but one order, which is defined as follows :

Vertebræ biconcave ; feathers arranged in one series on each side of the caudal vertebræ ; *Ornithopappi.*

To this order but one family belongs, viz., the Archæopterygidæ.

The superorder ODONTOLCÆ includes also but one order.

Teeth in a grove ; sternum without keel ; wings rudimental ; pelvic bones free posteriorly ; *Dromæopappi.*

The DROMÆOPAPPI has but one family, the Hesperornithidæ.

To the ODONTOTORMÆ one order only is referred. It is thus characterized:

Teeth in sockets; sternum keeled; wings well developed; ischium and pubis free posteriorly; *Pteropappi.*

The family of the Ichthyornithidæ is the only one known to belong to the PTEROPAPPI.

The superorder EURHIPIDURÆ includes all recent birds. There are three orders, which are defined as follows:

Palate dromæognathous; pelvic elements free posteriorly; *Dromæognathæ.*

Palate not dromæognathous; pubis free from ischium; integument covered uniformly with feathers, which are not differentiated on the wings; *Impennes.*

Palate not dromæognathous; vertebræ mostly saddle-shaped; ilia and ischia anchylosed behind; ilia anchylosed to sacrum; mandibular rami coössified at symphysis; feathers with definite local distribution, those of the fore limb much deferentiated; *Euornithes.*

The DROMÆOGNATHÆ include the following suborders:

Sternum without keel; clavicles; wings rudimental; *Struthiones.*
Sternum without keel; no clavicles; wings rudimental; *Apteryges.*
Sternum with keel; clavicles; wings rudimental; *Gastornithes.*
Sternum with keel; clavicles; wings functional; *Crypturi.*

The families belonging to these orders are the following:

Struthiones; Struthionidæ, Rheidæ, Casuariidæ, Dromæidæ, Dinornithidæ, Aepiornithidæ.
Apteryges; Apterygidæ.
Gastornithes; Gastornithidæ.
Crypturi; Crypturidæ.

To the IMPENNES but one suborder belongs. This is the Ptilopteri.

Ilium not anchylosed with sacrum; bones of wing not foldable on each other; metacarpals not separated; hallux directed forwards; feathers scale-like; vertebræ opisthocœlous; *Ptilopteri.*

The Ptilopteri includes the single family of the Aptenodytidæ or penguins.

The EUORNITHES include numerous suborders, which are defined as follows:

I. Maxillopalatines united across the middle of the palate. (*Desmognathæ*).

A. Four toes directed forwards (pamprodactylous).

Toes webbed; no basipterygoids; *Steganopodes.*

Toes free; vomer unossified; no basipterygoid processes; *Colioïdei.*

AA. Three toes directed forwards.[1]

Short basipterygoid processes; toes generally webbed; præcocial; *Chenomorphæ.*

No basipterygoid processes; bill and legs slender; toes generally free; altricial; *Herodii.*

Bill and claws hooked; toes free; altricial; vertebræ saddle-shaped; *Accipitres.*

Bill hooked; toes free; vertebræ opisthocœlous; rostrum movably articulated with skull; basipterygoids; *Heterospondyli.*

Toes free; vertebræ saddle-shaped; rostrum fixed; *Coccygomorphæ.*

AAA. Two toes directed forwards and two backwards.

Rostrum freely articulated with the skull; vertebræ opisthocoelous; *Psittaci.*

II. Maxillopalatines not united across the palate; vomer narrowed and acute in front. (*Schizognathæ.*)

A. Toes three forwards (anisodactylous).

Schizorhinal; toes webbed; *Cecomorphæ.*

Toes free; legs long; feathers with after shaft; præcoces; *Grallæ.*

No basipterygoids; lachrymal bones coössified with rostrum; toes free; *Opisthocomi.*

Toes free; hallux rudimental; *Gallinæ.*

Toes free; hallux well developed; two carotids; *Pullastræ.*

Toes free; hallux well developed; one carotid artery; basipterygoids; *Micropodioidei.*

[1] Except Cuculidæ, which are zygodactylous.

AA. Toes two in front (heterodactylous).

Toes free; hallux well developed; basipterygoids present; *Trogonoidei.*

III. Maxillopalatines not united on median line; vomer single, truncate, and excavated in front. (*Ægithognathæ.*)

A. Toes three in front (anisodactylous).

Toes free; hallux well developed; tarsometatarsus with five tendinous canals; basipterygoids wanting or rudimental; sternum with two notches; no cæca coli; one carotid artery; *Passeres.*

AA. Four toes directed forwards (pamprodactylous).

Toes free; no basipterygoids; sternum entire posteriorly; tensor patigii brevis muscle attached to a tendon which extends to the manus; no cœca; *Micropodioidei.*

IV. Maxillopalatines separate; vomer double, represented by two laminæ. (*Saurognathæ.*)

A. Two toes directed forwards.

Feet zygodactylous; no cœca coli; no interclavicle; one carotid artery; *Picoidei.*

The arrangement of the above orders is not expressive of their true affinities in all cases. Thus the Colioidei, Cocygomorphæ, Micropodioidei, Trogonoidei, and Picoidei, are more or less related, and sometimes brought together into a single heterogeneous order called the Picariæ.

The families of the EUORNITHES are as follows:

Steganopodes; Phætonidæ, Fregatidæ, Pelecanidæ, Sulidæ, Phalacrocoracidæ, Plotidæ.

Chenomorphæ; Palamedeidæ, Anatidæ, Phœnicopteridæ.

Herodii; Ibididæ, Ciconiidæ, Balænicipitidæ, Ardeidæ.

Accipitres; Cathartidæ, Falconidæ, Pandionidæ, Strigidæ.

Psittaci; Psittacidæ.

Cecomorphæ; Colymbidæ, Heliornithidæ, Alcidæ, Laridæ, Procellariidæ.

Grallæ; Chionidæ, Thinocoridæ, Glareolidæ, Dromadidæ, Charadriidæ, Otididæ, Eurypygiidæ, Rhinochetidæ, Cariamidæ, Psophiidæ, Gruidæ, Rallidæ.

Opisthocomi; Opisthocomidæ.

Gallinæ: Tetraonidæ, Phasianidæ.

Pullastræ; Cracidæ, Megapodiidæ, Pteroclidæ, Didídæ, Columbidæ.

Colioidei: Coliidæ.

Heterospondyli; Steatornithidæ.

Coccygomorphæ; Cuculidæ, Coraciidæ, Alcedinidæ, Upupidæ, Musophagidæ, Todidæ, Momotidæ, Bucerotidæ, Rhamphastidæ, Caprimulgidæ, Bucconidæ, Indicatoridæ.

Micropodioidei; Cypælidæ, Trochilidæ.

Trogonoidei; Trogonidæ.

Picoideæ; Picidæ.

Passeres. This order is divided into five superfamilies as follows:

Tensor patagii brevis picarian;			*Menuroidei.*
Tensor patagii brevis passerine; syrinx,	Mesomyodian,	desmopelmous;	*Eurylæmoidei.*
		bronchiotracheal; schizopelmous,	*Tyrannoidei.*
		tracheal; schizopelmous.	*Formicaroidei.*
	Acromyodian	schizopelmous;	*Passeroidei.*

The families of these superfamilies are the following:

Menuroidei; Menuridæ, Atrichornithidæ.

Eurylæmoidei; Eurylæmidæ.

Tyrannoidei; Xenicidæ, Philepittidæ, Pittidæ, Tyrannidæ, Cotingidæ, Phytotomidæ.

Formicaroidei: Conopophagidæ, Pteroptochidæ, Formicariidæ.

Passeroidei; Alaudidæ, Motacillidæ, Timaliidæ, Liotrichidæ, Muscicapidæ, Turdidæ, Cinclidæ, Troglodytidæ, Chamæidæ, Hirundinidæ, Artamidæ, Laniidæ, Paridæ, Paradisiidæ, Corvidæ, Sturnidæ, Meliphagidæ, Nectariniidæ, Certhiidæ, Ploceidæ, Tanagridæ, Icteridæ, Fringillidæ.

MAMMALIA.

Two subclasses are known to belong to this class.

An interclavicle; a large coracoid articulating with the sternum;	*Prototheria.*

No interclavicle; coracoid very small, coössified with scapula; not reaching sternum; *Eutheria.*

Of the PROTOTHERIA, there are probably three orders of which species are known, but the location of the two first enumerated below is not certain.

Incisors reduced; molars with compressed cutting crowns, and undivided roots; *Protodonta.*

Incisors enlarged; molars with tubercular grinding surfaces, and distinct roots; *Multituberculata.*

No true teeth at maturity; *Ornithostomi.*

The families are the following:

Protodonta; Dromatheriidæ.

Multituberculata; Tritylodontidæ, Plagiaulacidæ, Chirogidæ, Polymastodontidæ.

Ornithostomi; Ornithorhynchidæ, Echidnidæ.

The EUTHERIA are represented by the following numerous orders.

I. Marsupial pelvic bones (generally); palate perforated; (vagina double; placenta wanting; corpus callosum rudimental; cerebral hemispheres small.) (*Didelphia.*)

One deciduous molar tooth; *Marsupialia.*

II. No marsupial bones; palate generally entire; (one vagina; placenta and corpus callosum well developed.) (*Monodelphia.*)

A. Posterior limbs wanting, or represented by minute rudiments; anterior limbs oar-like. (*Mutilata.*)

Elbow joint inflexible; carpals discoid, and, with the phalanges, separated by cartilage; lower jaw without ascending ramus; *Cetacea.*

Elbow joint flexible; carpals and phalanges with close articulations; mandible with ascending ramus; *Sirenia.*

AA. Posterior limbs present; ungual phalanges compressed and curved on one or all the feet.[3] (*Unguiculata.*)

[3] Except Mesonychidæ, some Glires, and posterior feet of some Edentata.

β. Carpal and tarsal bones generally in linear series.

γ. Teeth without enamel; no incisors.

Limbs ambulatory; hemispheres small; *Edentata.*

$\gamma\gamma$. Teeth with enamel; incisors present.

No postglenoid process; mandibular condyle not transverse; mastication proal; limbs not volant; hemispheres small; *Glires.*

Anterior limbs volant; hemispheres small; *Chiroptera.*

A postglenoid process; mandibular condyle transverse; mastication orthal, no scapholunar bone;[4] hemispheres small, smooth; *Bunotheria.*

A postglenoid process; limbs not volant, with a scapholunar bone; mastication orthal; hemispheres larger, convoluted; *Carnivora.*

$\beta\beta$. Carpal and tarsal bones alternating; faceted.

Anterior limbs prehensile; mandibular condyle, and mastication transverse; *Ancylopoda.*

AAA. Posterior limbs present; ungual phalanges not compressed and hooked.[5] (*Ungulata.*)

β. Carpal, and usually tarsal bones in linear series.[6]

Limbs ambulatory; teeth with enamel; *Taxeopoda.*

$\beta\beta$. Tarsal bones alternating; carpals linear or reversed diplarthrous.

Cuboid bone partly supporting navicular, not in contact with astragalus; no canine teeth; *Proboscidea.*

$\beta\beta\beta$. Both tarsal and carpal series more or less alternating; the distal row inwards.

Os magnum not supporting scaphoides; cuboid supporting astragalus; superior molars tritubercular; *Amblypoda.*

Os magnum supporting scaphoides; superior molars quadritubercular;[7] *Diplarthra.*

[4] Except Talpa and Erinaceus.

[5] Except in the Hapalidæ.

[6] Except in Dendrohyrax.

[7] Except Pantolestidæ.

The families embraced in the above orders are the following:

MARSUPIALIA; (*Polyprotodontia*); Triconodontidæ, Amphitheriidæ. Myrmecobiidæ, Dasyuridæ, Didelphidæ, Peramelidæ; (*Diprotodontia*); Phascolomyidæ, Phalangistidæ, Tarsipedidæ, Diprotodontidæ, Macropidæ, Thylacoleontidæ.

CETACEA; (*Archæoceti*); Zeuglodontidæ; (*Odontoceti*); Squalodontidæ, Platanistidæ, Physeteridæ, Delphinidæ, (*Mystacoceti*); Balænidæ.

SIRENIA; Prorastomidæ, Halitheriidæ, Manatidæ, Halicoridæ, Rhytinidæ.

BUNOTHERIA; (*Pantotheria*); Amblytheriidæ; (*Creodonta*); Mesonychidæ, Esthonychidæ, Arctocyonidæ, Miacidæ, Hyænodontidæ, Leptictidæ, Centetidæ; (*Insectivora*); Galeopithecidæ, Tupæidæ, Solenodontidæ, Macroscelididæ, Talpidæ, Adapisoricidæ, Mythomyidæ, Scalopidæ, Chrysochloridæ, Erinaceidæ, Myogalidæ, Soricidæ; (*Tæniodonta*); Ectoganidæ, Stylodontidæ; (*Tillodonta*); Tillotheriidæ.

EDENTATA; Orycteropodidæ, Manidæ, Bradypodidæ, Megatheriidæ, Myrmecophagidæ, Dasypodidæ, Glyptodontidæ.

GLIRES; (*Simplicidentata*); Sciuridæ, Muridæ, Hystricidæ; (*Duplicidentata*), Leporidæ.

CHIROPTERA; (*Animalivora*); Phyllostomidæ, Desmodontidæ, Rhinolophidæ, Noctilionidæ, Vespertilionidæ, Emballonuridæ; (*Frugivora*), Pteropidæ.

CARNIVORA; (*Fissipedia*); Cercoleptidæ, Procyonidæ, Æluridæ, Canidæ, Bassaridídæ, Mustelidæ, Protelidæ, Arctictidæ, Viverridæ, Cynictidæ, Suricatidæ, Cryptoproctidæ, Nimravidæ, Felidæ, Hyænidæ; (*Pinnipedia*); Phocidæ, Otariidæ, Odobænidæ.

ANCYLOPODA; Chalicotherriidæ.

TAXEOPODA; (*Condylarthra*); Periptychidæ, Phenacodontidæ, Meniscotheriidæ; (*Toxodontia*); Proterotheriidæ, Mesotheriidæ, Toxodontidæ, Macraucheniidæ; (*Hyracoidea*); Hyracidæ; (*Daubentonioidea*); Chiromyidæ; (*Quadrumana*); Mixodectidæ, Adapidæ, Anaptomorphidæ, Tarsiidæ, Lemuridæ, Hapalidæ, Cebidæ, Cercopithecidæ; (*Anthropomorpha*); Simiidæ, Hominidæ.

PROBOSCIDIA; Dinotheriidæ, Elephantidæ.

AMBLYPODA; (*Taligrada*); Pantolambdidæ; (*Pantodonta*); Coryphodontidæ; (*Dinocerata*); Uintatheriidæ.

DIPLARTHRA; (*Perissodactyla*); Lophiodontidæ, Triplopidæ, Cænopidæ, Hyracodontidæ, Rhinoceridæ, Tapiridæ, Lambdotheriidæ, Menodontidæ, Palæotheriidæ, Equidæ; (*Artiodactyla*); Pantolestidæ, Eurytheriidæ, Anoplotheriidæ, Dichobuniidæ, Cænotheriidæ, Anthracotheriidæ, Xiphodontidæ, Suidæ, Hippopotamidæ, Merycopotamidæ, Dichodontidæ, Oreodontidæ, Poëbrotheriidæ, Protolabididæ, Camelidæ, Eschatiidæ, Tragulidæ, Moschidæ, Bovidæ, Cervidæ.

NOTES ON THE ARCHEOLOGY AND ETHNOLOGY OF EASTER ISLAND.

BY WALTER HOUGH.

EASTER Island forms the southwesterly extremity of the Polynesian Archipelago, in S. lat. 27°, W. long. 109°, about 1900 miles west of Santiago, Chili. It is roughly twelve miles long by four wide, volcanic in origin. It is inhabited now by a remnant of Malayo-Polynesian stock.

From an archeological point of view, this island is very interesting; stone images, carved stones, subterranean dwellings, weapons, tools, cave ossuaries, etc., abound. One of the last acts of the late Professor Spencer F. Baird was to induce the Navy Department to send a vessel to explore the island, and bring back representative specimens. The U. S. S. Mohican, then at Tahiti, was detailed, and the fruits of the successful twelve days' exploration are to be seen in the North and West halls of the National Museum, consisting of several stone images, carved stones, painted slabs, and the fine collection of smaller objects procured by Paymaster W. J. Thomson, U. S. N.

The museum is indebted to the latter gentleman, and to Surgeon Geo. H. Cooke, U. S. N., for information concerning the specimens and the people of the island.

The largest figure collected is a torso and head (Fig. 1) weighing three tons, and standing over eight feet high, made of a porous volcanic rock, probably friable basalt lava, or tufa. The

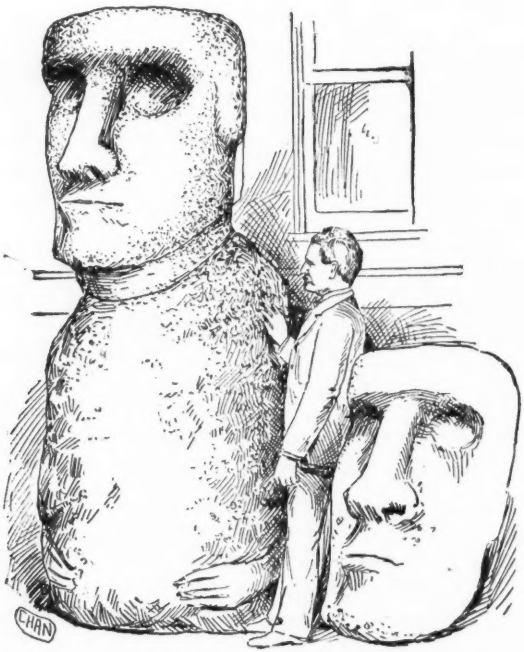

FIG. 1.—EASTER ISLAND IMAGES IN NATIONAL MUSEUM.

face is very broad, with crude features. Large eye-sockets are cut out for the reception of pieces of obsidian representing eyes. The arms clasped over the breast are only outlined; all the statues have only the face modeled, that part being worked out with the highest skill possessed by the artists. In detail, this is shown by the nose. The septum is wide, as in the Papuan nose, and the

alæ are prominent. The lips protrude with a pouting expression. The oval eye-sockets measure 13 by 8 inches. The ears are 21 inches long, not modeled except in general outline, and having a few shallow grooves. The edges of the lower jaw are sharp, and the neck is cut squarely into the breast. A necklace is apparently marked out. The pectoral mammæ are obscurely shown. The back of the figure is nearly flat, and parallel verti-

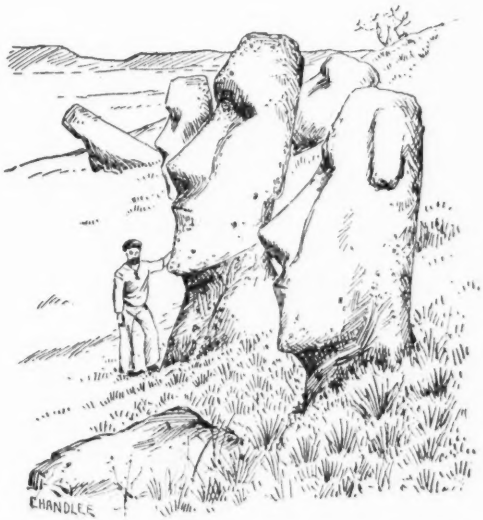

FIG. 2.—IMAGES PARTIALLY BURIED IN THE DEBRIS IN CRATER OF RANAKAU.

cal grooves show how the image was chopped out. The stone is wreathed and covered with lichen, so that there are scarcely any traces of tool marks. Certain rounded blocks of very vesicular rock are crowns that were placed upon the flat heads of the figures. Characters are seen carved on the side of the crown.

Originally from six to fifteen colossi were set upon long but narrow platforms or terraces of stone. There are various conjectures as to their meaning. Mr. Thomson thinks they were merely

commemorative, and that the platforms were burial places of the chiefs. Nearly all the six hundred figures on the island are prostrate, it is not known through what agency. The platforms are 113 in number, and the largest found was 150 feet long, 9 feet high, and 6 feet wide. With the original wings, it would

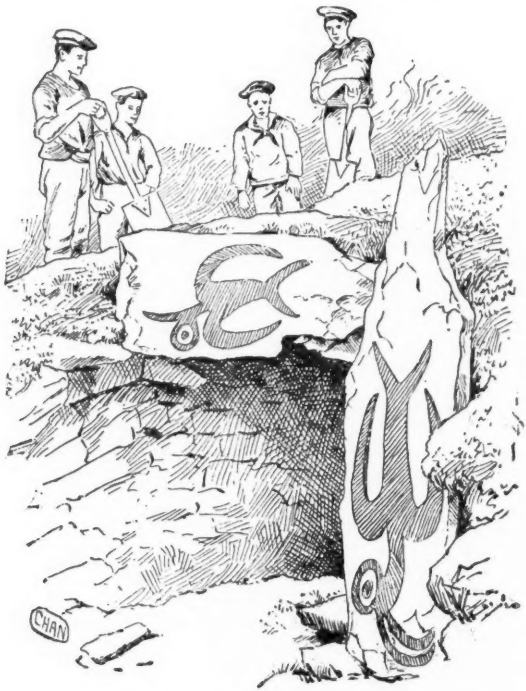

FIG. 3.—MOHICAN PARTY UNCOVERING A HOUSE.
(Slabs in the National Museum.)

have been 340 feet long. The images are of various sizes, the largest 70 feet in height.

The workshop and quarry where the workmen got these figures out was in the crater of the extinct volcano of Ranakau, now partially filled with a marsh, and showing in places the cavernous cliff of its ancient rim. There are dozens of images yet in the

crater. (Fig. 2.) No metal was known; the tools were chisels and adze blades of tough volcanic rock. They cut into the cliff, outlining and rounding the figure until it was detached, then probably mounted it on skids, and dragged it to its destination.

Though the volcano is 1400 feet in height above sea-level, the crater is easily accessible over a low, sloping place in its rim. How these people moved these images over the singularly difficult topography the island presents, is a problem. They moved monoliths 60 feet high, weighing at least 50 tons, twelve miles, and set them up! This, too, without any timber, except driftwood. Many of the images were abandoned, however; they are strewn all the way from the crater—the only place where suitable rockwas found—to the platforms.

FIG. 4.—SPEAR HEAD OF OBSIDIAN.

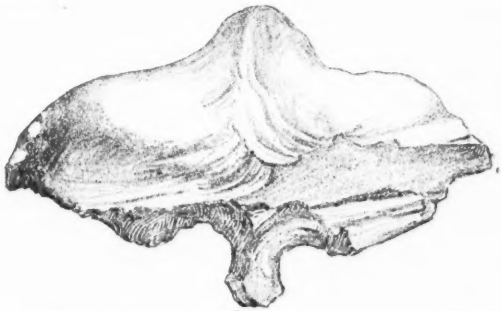

FIG. 5.—SPEAR HEAD OR BATTLE AXE MADE OF OBSIDIAN.
(From specimens in the United States National Museum.)

The houses found on the island were arranged in parallel rows facing the sea, built of small irregular slabs of stone. They

have one room, usually measuring fourteen feet long by six in width, and five feet two inches high, with walls in some cases five feet thick. They are lined and roofed with pictured slabs (Fig. 3), and a mound of earth was heaped over the top. The doorways are on a level with the ground, and are so narrow that it is difficult to squeeze into the chamber. One of these slabs, weighing about six hundred pounds, brought in the Mohican, has the picture of a bird, or marine animal with a bird's head, in red and white, with outstretched wings, upon it. In these subterranean houses Mr. Thomson found many peculiarly-shaped obsidian spear heads. They resemble, somewhat, ancient battle axes, and are supposed to have been used as missiles, and, hafted on poles, as spears. There are several distinct forms (Figs. 4 and 5). Stone fish hooks, adze blades, round stones, are found also on the surface and in the houses.

Mr. Thomson procured two slabs of wood, one 9½ inches by 3½, the other 24 inches by 4½ inches, covered with rows of hieroglyphics. The somewhat remarkable fact that these people wrote has been known for years. These tablets were said to have been numerous on the island some years ago, but were destroyed through the zeal of Catholic missionaries. There are now but some seven or eight in existence, held by the Bishop of Tahiti, the British and the U. S. National Museums. The Bishop of Tahiti observed the natives consulting these tablets, and obtained, as he thought, a translation of them. It has been found that the islanders were using them merely as a mnemotechnic device to aid them in running back the genealogy of their chiefs, and did not follow the characters in the obvious way that they were written. The characters are about half an inch in height, beautifully carved, it is supposed with shark's teeth. They carry their meaning in the thing they represent, and are followed by beginning at the left hand lower corner on the particular side of the tablet that will bring the characters erect. Finishing the lower line with the figures turned toward the reading, and going to the next line above, the reading is continued from right to left (boustrephodon). In order to have the images face the same

way, it is necessary, in reading a new line, to turn successively the right side of the tablet to the left.

The native traditions state that their ancestors came from. Rapaiti (27° 35′ S. lat., 144° 20′ W. long.) under Chief Tocuyo, and that twenty-two chiefs have succeeded him up to twenty years ago (about 500 years).[1] They say that Tocuyo knew the language of these tablets, and brought with him sixty-seven tablets containing allegories, proverbs, and traditions of the country from

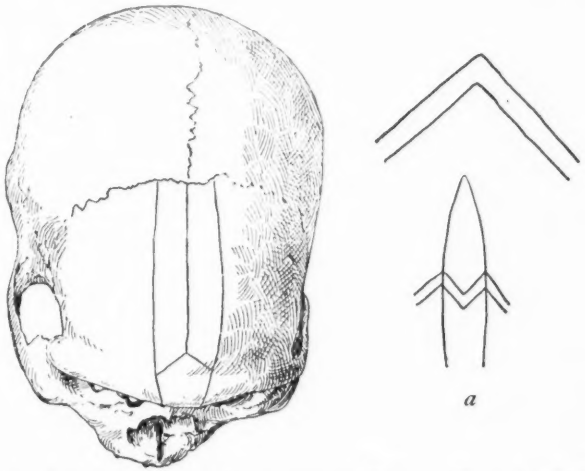

FIG. 6.—SKULL WITH SIGN ENGRAVED ON FRONTAL BONE, (*a*) DESIGNS FROM OTHER SKULLS.

(From specimens in the United States National Museum.)

which they came. A certain number of youths from each clan were instructed in the reading of these writings, and on a great fête day, once a year, the people assembled to hear them read Some characters like those on the tablets appear on the platforms and the doorposts of the ancient stone houses. Three skulls (Fig. 6) in the Thomson collection have each a character deeply cut in the frontal bone. These skulls were said by the natives to have been of their chiefs.

[1] Palmer, Visit to Easter Id. *J. Roy. Geog. Soc.*, XL., 1870.

Hieroglyphs like those of the tablets also appear on the door-posts, slabs, and in other places. Near the platforms and houses are many curiously-carved stones, sometimes on rock masses and again detached grotesque carvings. Fig. 7 represents one of the latter.

THE NATIVES.—The natives number at present about 155; it is supposed that on the discovery of the island by Roggeween in 1722 there were 20,000. Having lived so long in isolation, they were peculiarly ill-adapted to stand the pressure of a higher civilization. Their history for the past 150 years has been one of constant wars: some have said that missionaries were the cause, and that during these strifes the monuments were thrown down. Chili impressed several ship-loads of natives as coolies some years ago. The remnant are pure Polynesians; their language, arts, and religion are those common to that stock. They make tapa, or mulberry bark cloth, for clothing, and plaited mats of bulrushes to sleep upon. In Mr. Thomson's collection there are several crownless hats made of the feathers of fowls. There are six different styles. The hat worn by the dancing women is small and narrow, with feathers of bright color overlapping all the way around. The married women's hat, worn upon the ceremony connected with a bethrothal, is broad, made of black feathers about six inches long, clipped evenly all the way around. The men at their food feasts wore a small hat of feathers, with long tail feathers hanging behind. The hat of the chief, worn as an insignia of office, is large and heavy, clipped evenly, the back ornamented with the largest and finest feathers to be had. The minor officials and chiefs (*ex officio*) wear a lighter hat, made

FIG. 7.—GROTESQUE CARVING IN STONE, EASTER ISLAND.
(From specimens in U. S. National Museum.)

of short black feathers, with four tail feathers on end, and tending outward at regular intervals. The head-dresses are highly regarded.

There seems always to have been a scarcity of timber; this accounts for the houses differing from the Polynesian dwelling in being made of stone.

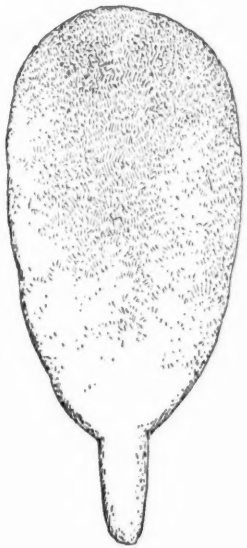

FIG. 8.—CONJURING PADDLE MADE OF BONE OF WHALE.

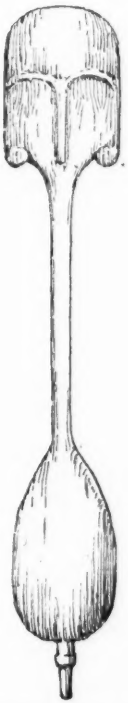

FIG. 9.—POTATO FETISH OF WOOD CARVED AND PAINTED IN RED.

(Both from specimens in the United States National Museum.)

They lived principally on fish, though the yam, taro, bread-fruit, banana, and other food supplies were drawn upon. Hooks were made of bone; nets were made of hemp. The bonito, a mackerel, was the principal fish caught.

Weapons were clubs and spears; it is presumed that the bow and arrow were not in use. Mr. Thomson says that hemp nets were used in fighting.

Conjuring wands were used by the natives. One, a broad paddle of bone of the whale, 30 inches long (Fig. 8), is supposed to possess power to work a charm on an enemy. The shaman working the spell performs a convulsive dance, making mysterious movements with the wand, and muttering incantations. Such charms are believed to bring speedy death upon their victim. A special potato paddle, called *raha*, was stuck in the ground to protect the potato crop from drought, insects, and evil spirits (Fig. 9). These paddles are of wood, painted red, and with a blade on each end. Ceremonial paddles of the same shape as the latter, but larger, with one blade grotesquely painted, were used, as were long clubs with a double head carved on one end, by chiefs when addressing assemblies.

Rude, unshapen stones were distinguished by the natives as gods of three varieties. These are the fish god in general, called *Mea Ika;* the bonito's god, called *Mea Kahi;* and the fowl god, called *Mea Moa.* The gods were never common, and were possessed by clans or communities, and never by individuals. They were moved about from place to place as they were needed. An especial god being set apart for the bonitos is attributed to the fact that that fish has always been abundant and highly prized as food.

Who were the people whose remains have been noticed?

This question is asked because there are several theories that rule out the ancestors of the present occupants of the island as authors of the works. It has been argued that they were not:

1st. Because the Polynesian, as we know him, is averse to sustained labor. This argument would perhaps apply at present, but it is evident from all accounts that all groups of the island race were energetic in building houses, canoes, in seafaring, and in many places (a list is given in Waitz's Anthropologie, Vol. V.) made stone edifices and sculptures of great extent. There is a pyramid in Tahiti 260 feet long, 90 broad and 40 high, made of squared stone.

2d. Because the present Easter Islanders do not know about the ruins, but say, "The gods made them." This failure or incompleteness of record is a matter of common observation.

3d. The strange facies of the remains. While some local modifications exist in the island, these monuments were no doubt built under the same impulses that prompted the erection of megalithic structures everywhere.

4th. The fact that writing was known. The discovery of the engraved slabs brings out an unique phase of progress not known elsewhere in the units that go to make up the Polynesian race. Until the tablets are read there is doubt as to the character of the record, whether they are lists of chiefs or a sequence of ideas in written language. There seems to be a pretty clear tradition as to the introduction of the tablets, and those that I have seen, from their state of preservation do not appear to be very ancient. However, it would seem but a small step from the plaiting of hieroglyphic tabu signs, spoken of by Turner among the Samoans (Samoa, p. 185), to the delineation of them on surfaces, and this step may have been taken in this case.

In the dry caves of the island are skulls of the supposed former inhabitants, that might, if craniometry were of any value in race classification, throw some light on the inquiry.

A people who have been thought possibly to have been the builders of the Easter Island remains, are the Papuans. It is said that they are more energetic than the Polynesians, and are hence more likely to have undertaken the difficult works. The art has also been thought to have a Papuan appearance.

Conclusions of this kind are very unstable, because based on an uncertain premise. It is probable that a judicial review would show the facts equally pointing to the agency of the ancestors of the miserable remnant of Easter Islanders in the works. The presumption should always be in favor of an existing tribe against unknown peoples; but it is one of the sins of ethnologists that they have "gone after strange gods," and dealt too much in mere speculation. The language of the Easter Islanders should be closely examined for words derived from other sources; language

shows admixture more convincingly than arts, but not more in reality to those who are in a position to make comparisons.

The remark of Prof. O. S. Mason is a reliable statement of the question for the present, that "the Easter Island images are the most interesting of the archeological enigmas." Mr. Thomson is preparing a monograph on Easter Island for a forthcoming Smithsonian Report, from the material gathered on the Mohican survey and from other sources, which will allow a judgment to be passed on these questions, and which will give all that is known about the archeology and ethnology of this interesting field.

ARE THE GERMAN SCHWEINE-SEUCHE AND THE "SWINE PLAGUE" OF THE GOVERNMENT OF THE UNITED STATES IDENTICAL DISEASES?

ONE of the most valuable and interesting contributions to the literature of the German Schweine-seuche is that of Bleisch and Fiedeler.[1]

The investigations of these observers appear to have been most carefully made, and every necessary precaution used. They extended over fifty-two swine, in an outbreak in which sixty of sixty-three died. According to their statement, the same micro-organism to which the name "Loeffler-Schütz" has been given, was found in every case, of which they say: "While the dispersion of the bacteria in the organs and blood of the inoculated rabbits and hens is in general about equal, these investigations show that in swine they are most numerous in the mucus filling the bronchial tubes which lead to the diseased portions of the lungs, and less numerous in the caseous parts, while equally scarce or wanting in the gray-red hepatized portions as well as in the spleen and liver.

[1] "Beitrag zur Kenntniss der Schweine-seuche." *Zeitschrift für Hygiene* (Koch's), Vol. 5, p. 400, and *Archiv für wiss. und prac. Thierheilkunde*, Vol. 5, 1889.

The most interesting and important point regarding these observations is the relation of the lesions in the intestines to epizoötic swine diseases in this country. *In the fifty-two hogs examined we do not find intestinal lesions mentioned once;* but do meet with such expressions, over and over again, as, "*Nothing abnormal* in the intestines." On the contrary, pulmonary changes varying in degree were present in each case, and formed the essential lesion.

Summing up the results of their microscopical observations, these investigators say that "the skin and sub-cutis showed no changes," which is somewhat contradicted by Schütz and Loeffler's experience, both of whom frequently mention the presence of "enormous œdema." Going on they say, "In most cases the diseased changes were limited to grayish-red hepatization of the inferior portion of the anterior lobes of the lungs and medullary swelling of the lymph-glands. Further lesions were also present in the middle and inferior lobes; the bronchial tubes always formed the central point of these consolidations. Where the disease had become more progressed the hepatized tissues were more dry, and yellowish-red in color; coseation was present in still older centers. *In the other organs, especially the cutis and sub-cutis, liver, kidneys, bladder and gastro-intestinal canal, no pathological changes were to be seen.*

"Our investigations show that we have had to do with an exceedingly infectious disease of the lungs having a chronic course, *which can extend to healthy animals without any contact with diseased ones* (hence not contagious), and that the infecting element, in almost all cases, finds its way into the infested organism by means of the lungs. *In all cases the pathological changes do not extend much beyond the point of invasion. The disease retains, almost invariably, a local character. Especially do we entirely miss any mentionable changes in the spleen and intestines.*"

The authors also quote Schütz upon this point as follows:

"Schweine-seuche (swine plague) is an inflammation of the lungs and pleuræ which is found with necrosis of the diseased portions of the lungs and mild phenomena of infection, little or no swelling of the spleen, slight swelling of the parenchymatous

organs, and gastro-intestinal catarrh. When the disease assumes a chronic course caseous conditions in the lungs are produced."

"*Caseous changes in the mucosa of the stomach and intestines have not yet been observed.*"

The desperate attempts which have been made to graft a second "*wide-spread epidemic disease*" upon the porcine interests of this country, under the name of swine plague, which should be a pest, something which sweeps life away, both by the Agricultural Department, and its notorious "Board of Inquiry," as well as by Prof. Welsh, of Johns Hopkins University, Baltimore, and to establish the identity of this hypothetical and totally non-existent "pest" with the Schweine-seuche," demand some attention here.

As is well known, it has been the writer's endeavor to protect the hog-growers of the country from the absolutely baseless assertions of their government, and it is appropriate to call attention to the fact that this second "wide-spread epidemic among the hogs in this country," this terrible bureaucratic pest, never made its appearance until the author had made public the results of his earlier investigations in Nebraska. The report in which this second pest is first described is dated 1886, but was not published until 1887.

In a recent letter sent to the agricultural press of the country, and in which the Agricultural Department of this country cries "baby," it is claimed that the work of that department has been honest and scientific. If it has, then, why cry for support? In that report of 1886, this second terrible pest is described as a pulmonary trouble pure and simple. In the next report, of 1887 (issued 1888), we cannot tell what it is, for though honest and scientific in its work, the government so mixes up things that no human being can tell what this pest really is. We are told that "the lung lesions point to the existence of swine plague, and that the intestinal lesions indicate that of hog cholera," also in the same pig; that this pest is an "infectious pneumonia;" of "the difficulties attending investigations of diseases which have their seat in the lungs," though the government does say that "*in none of these experiments was the disease reproduced,*" and then it says, when speaking of its correct "diagnosis," "The

disease just described cannot fail to be recognized, as it seems to be the only severe disease of the lungs among swine of which we have any knowledge."

Now, when we read all those quotations, and compare them with the statements of the essential lesion of the German "Schweine-seuche," and when we read that the government claims the germ of its second "wide-spread plague" is identical with that of the German disease, it does certainly look as if the government work has been honest and scientific; even more so, in fact, than when it carelessly claimed of its non-existing micrococcus of 1880 to 1885, that "the evidence furnished is all that should be necessary to decide a scientific question of this kind." But as then, so now, the work of the government is not and has not been either careful or scientific, if we can believe a single one of its assertions, for though it did give "evidence which should decide a scientific question of this kind," although it does seem to show in what we have quoted that the German and government plagues are really and truly pulmonary in character, and nothing else, still they make other equally honest and scientific assertions which, if the German evidence of Professors Loeffler and Schütz, and these two later observers, can be taken as correct, must certainly force any honest man to see that the government's assertion as to its "swine plague" being an "infectious pneumonia," and identical with the German disease, is neither careful nor scientific; for, in that same report of 1887, these honest (?) observers tell us of *Intestinal lesions!* "In the severe types of this disease there are very extensive lesions of the large intestines." And a government observer did say, in April, 1888, that some investigators think that the bowel lesions of hog cholera and the lung lesions of infectious pneumonia are caused by the same germ.

Do such assertions look like true, honest, and scientific statements? Can any ordinary layman see any signs of identity between a disease in which "there are very severe lesions in the large intestine," and this German disease, in which there was not a single disturbance in the intestines in a single one of 52 hogs most carefully examined, as well as in those studied with per-

haps still greater exactness by both Professors Schütz and Loeffler?

I am perfectly well aware that lesions similar to those found in the large intestine have also been found in hogs in Germany, but think they require an entirely different interpretation. These intestinal lesions were first described by Roloff in 1875, under the name of "Chronic Caseous Enteritis in Swine;" and it is a very singular fact that from that time until now not one single case of such lesions in swine has been described by German observers. Professor Schütz was inclined to the opinion that these so-called "characteristic lesions" in the large intestine, so common n, but not necessary, to the true American swine plague, might also be found to belong in the pathological picture of the German Schweine-seuche, and in my earlier writings in several periodicals I inclined to the same opinion, being misled by the more or less close resemblance in the description of the germs of the German disease to the morphological appearances of those of the American. I, however, entirely changed my opinion as to identity between the German Schweine-seuche and the true swine plague of this country, called by the Government "Hog Cholera," in my full report published in the spring of 1889. Notwithstanding this latest and only real authentic publication of my ideas on this subject, a late writer, Prof. Welsh, of the Johns Hopkins University, says, in a "Bulletin" of that institution, December, 1889: "Much confusion has resulted from Dr. Billings' attempts to identify this organism (of 'Hog Cholera') with that of the Schweine-seuche."

I pronounce that assertion to be unequivocally false. The "confusion" has been raised entirely by careless, unqualified or ignorant writers who have endeavored to prove that the government swine plague is identical with the "Schweine-seuche."

To show how prejudiced and biased this committee may be, and how weak a man can be, though honored with a responsible position in a respectable university, and how economical of the truth such a person may be, I quote a few lines from my report on swine plague, where I am endeavoring to show that the German Schweine-sueche cannot be

identical with the real American swine plague, but is really nothing more or less than the "Wild-seuche," a disease differentiated by Bollinger from anthrax by the absence of *B. anthracis*, though he did not discover its germ, the microscopes and methods of investigation not being equal to that task at the time.

I said that the Schweine-seuche was not the swine-plague ("Hog Cholera") because, first, enormous œdema and deformation of the body thereby does not occur in swine plague; second, because the tendency to hæmorrhagic effusions is not a constant phenomenon, though frequently present, but seldom to such an extended degree as in the German disease; third, because the so-called "characteristic" intestinal lesions seem to be entirely absent.

Hence it seems to me that my conclusion is correct, that the organism discovered by Loeffler in swine, and the disease resulting from its action, has no important relation whatever to the origin and nature of the cosmopolitan swine plague.

It seems to me that the above language is plain enough to be understood by anybody.

That even foreigners can read the English language more correctly than one native to a country where it is spoken, I quote from the *Jahresbericht über pathogenen Microorganismen*, 1889, p. 130, where the reviewer of my work says: "While in a previous work I had the opinion that the American swine plague and the German Schweine-seuche were identical diseases, in this book (my Swine Plague) I most emphatically contradict this opinion, and claim the Schweine-seuche to be identical with the Wild-seuche," which latter assertion the reviewer questions.

Having thus most completely disposed of the careless inaccuracies of my critics, I will say that I am still of the same opinion, and it remains for German observers to show that I am not correct.

It will be remembered that the observations of Bleisch and Fiedeler extended over fifty-two diseased swine, not one of which presented anything abnormal in the intestinal canal. I will not take the trouble to refer to the exact number of swine examined by Loeffler and Schütz, but it was about ten.

Now I make bold to say, and do it with an experience extending over 1500 swine, on every one of which careful autopsies were made, that no man can examine not sixty but ten swine in this country in a large outbreak, where a pestiferous disease is raging and the loss anywhere from thirty to seventy per cent., and not find a majority of the cases presenting some form of a caseous, ulcerative or follicular lesion in the large intestines.

This should be evidence enough that the two diseases are not identical.

This Baltimore authority (who, by the way, is an almost entirely unknown quantity in the annals of bacteriology, for which assertion I refer the reader to the Annual Report previously quoted), and the scientific Department of Agriculture of this country, as well the members of the celebrated "Board of Inquiry," have, as is well known, done their utmost to injure the swine interest of the west by publishing to the world that the Government swine plague is identical with the German Schweine-seuche. It has been shown that had the government stuck to its original text, that its swine plague was a pneumonia only, it had all the evidence on its side. But it has also been shown that the government did not stick to its text, that its assertions have been neither accurate nor scientific, and that in its swine plague there were to be found fully as severe intestinal lesions as in the real hog-cholera, and the Board of Inquiry even went so far as to endorse this view. It even asserted that both the germs of the government pest and the hog-cholera produce almost identically the same lesions (I cannot see where they differ), and they both can be in one and the same hog at one and the same time.

Poor piggy!

Compare this latter statement with all the examinations of German observers.

Can we find anywhere a particle of evidence in favor of any such peculiar condition of things?

Thus far we have been unable to find any evidence of but one disease and one form of micro-organismal etiological life, and all the evidence goes to show that pulmonary lesions are its specific

complication, while intestinal are conspicuous by their absolute absence.

Nowhere do we find any description of any such organism as the hog-cholera germ being mixed up with the Schweine-seuche bacterium.

There is, however, another side to this question, and as I am not writing as an advocate, but as an honest searcher for the truth, it is but right to present it here. It has been previously mentioned that Roloff described intestinal lesions the exact counterpart of those frequently met with in the true American swine plague, and that Schütz, in 1886, thought that they might also belong to the Schweine-seuche.

It is also known that Schütz looked upon the "Schweine-pest" of Denmark as identical with the English "swine fever," and our true swine plague or hog-cholera, and that he did not think it identical with the Schweine-seuche, and that he did think intestinal lesions its chief characteristic in contradistinction to the pathognomonic pulmonary lesions of the Schweine-seuche is evident when he says the "*Schweinepest* is a disease of the digestive tract, by which especially the cæcum and colon are complicated."—B. & F., l. c., p. 434.

This certainly should go to show that Schütz had no actual knowledge of any swine disease in Germany with marked intestinal lesions up to the date of publication, July 3, 1889, or else those authors would have known of it, except the historical description of Roloff's in 1875.

Since B. and F.'s contribution, however,—in fact very recently—there have been published in Germany,[2] some observations which again describe the presence of the lesions observed by Roloff in a most exact manner, and, singular to say, with scarcely any mention of pulmonary complications being present.

From the title selected by Peters, "Schweine-seuche," and from the entire context, it is very evident that he came to the same conclusion which I did on first reading Schütz's descriptions, for he quotes Schütz on this subject as follows: "In an-

[2] "Die Schweine-Seuche." Peters. *Archiv für wissen. und pract. Thierheilkunde.* Berlin, 1890.

ticipation of the future I will draw attention to a disease of swine described by Roloff, under the name of caseous enteritis, which most probably should be recognized among the pathological processes caused by the the ovoid bacteria" of Schweine-seuche. Peters seems to be well aware of the fact that Schütz did not meet with these lesions in any of the hogs he examined, for he says: "We distinguish two etiologically different diseases, the Rothlauf of swine, and the Schweine-seuche: the first is pure septicæmia, caused by a bacillus, the last a general disease caused by an ovoid bacterium, in the course of which, so far as known, a multiple mortifying pneumonia is developed. The anatomical picture of such a pneumonia was at least presented by all the swine examined by Prof. Schütz."

The work of Bleisch and Fiedeler seems to have been unknown to Peters. Aside, then, from the before-mentioned reference to Roloff's observations in 1875, it is evident that the German investigators acknowledge but two specific swine diseases in that country, and while I do not desire to be a special pleader for my own hypothesis as to the conditions there, still it is only fair to call attention to a peculiar result of the appearance of the Loeffler-Schütz Schweine-seuche in the pathological arena, and that is, we hear no more of the "Wild-seuche." As previously noted, Peters follows Schütz implicitly, and assumes the latter's hypothesis as to the Roloff lesions in the intestines to be unqualifiedly correct, and says, "for the correctness of the assumption that the caseous enteritis should be classed with the Schweine-sueche, I am in a position to furnish the necessary material.

"The necroscopies which I have made upon such swine did not all give a corresponding result, *on the contrary, the bacterial results were the same in every case, namely, the presence of ovoid bacteria.* In four of the cadavers the pathological changes were exclusively in the large intestine, in one other alone, besides these, there was a multiple necrotic pneumonia."

It is not necessary to quote the details of the microscopical examination of these five hogs, of the results of which Peters says: "Through the previous examinations it can well be considered as proven that all the swine examined had suffered from one and

the same disease which was caused by the Schweine-seuche bacteria. We may also conclude that the multiple inflammation of the lungs, which was exceptionally and only present in the cases investigated by Schütz, is not an integral element of the pathological picture of Schweine-seuche, and that the hypothesis of that observer has been proven. Inflammation of the lungs occurs in this pest, as it presents itself here, probably much more frequently than caseous enteritis, as in the five cases examined by me it was only present in one, and there as a secondary local infection. To this assertion I find myself the more justified in that at the time I did not know of the identity between the caseous enteritis and Schweine-seuche. I had met with the first much the more frequently, without its being complicated with pulmonary lesions."

Let us consider this evidence as unprejudicedly and carefully as we can.

1. What have we in favor of the identity of the disease studied by Peters and that investigated by Loeffler, Schütz, Bleisch, and Fiedeler?

Nothing but that most unreliable of all evidence, the presence of a morphologically (apparently) identical micro-organism.

This kind of evidence is the most misleading and dangerous which can possibly be relied upon.

Let us suppose that it were possible to infect five hogs with the germ of ether Texas Fever, as it is called, the hen-cholera, rabbit-septicæmia, the weasel pest, or the corn-stalk disease, all of which are ovoid and belted bacteria, morphologically not safely to be diffentiated from those of the Schweine-seuche—what then?

But the germs of the last disease have no movement, and do not grow on potatoes, say some!

Well, what then?

There is no evidence that Peters made any such examination of a culture, as he certainly would have mentioned it.

2d. What have we against any such identity between the disease investigated by Peters and the Schweine-seuche?

In the Peters case we have four hogs with no pulmonary lesions whatever in comparison with over 60 examined by the

other observers, in none of which was there a single intestinal lesion.

To my mind, this is conclusive evidence that, notwithstanding the apparent resemblance between the microorganisms, as concluded by Peters, the disease studied by him was the hog-cholera of this country; and even if we take Schütz's conclusions, not the Schweine-seuche, but the Schweine-pest of Denmark, which is now generally admitted to be the same thing as the pest that decimates our herds.

If any value can be placed upon the testimony from Germany as we now have it before us, it must be admitted that it is still all in favor of my own conclusions as published in my complete report upon swine-plague in this country; that is, that the Germans are blessed with three distinct swine-plagues, varying, according to present evidence, in extent as follows:

1st. The Rothlauf, or Rouget (erysipelas).

2d. Hog-Cholera, or the Swine-pest, or genuine swine-plague.

3d. Schweine-seuche or the Wild-seuche.

While according to present evidence the third is more prevalent than the second of this series, I have placed it last because I desired to quote some peculiar testimony given by Bleisch and Fiedeler.

The Wild-seuche takes its name from the fact that attention was first called to it from its occurring among the wild animals in the Royal preserves, especially deer, which in Germany are called "das Wild." Up to the time of Bollinger's investigations this disease was classed with anthrax, but as said before, Bollinger did not discover its germ at that time. Whether or not future investigations will justify my hypothesis (see my report) that this Wild-seuche and the Loeffler-Schütz Schweine-seuche are one and the same disease I know not, but it is positively certain that all the evidence is at present in my favor.

It is very singular how limited the study of this question has been in Germany, since Schütz's first investigations in 1885, notwithstanding the extraordinarily favorable conditions for such work in the veterinary schools and laboratories of that country.

The fact that the Wild-seuche attacks cattle and hogs on the same territory and under the same circumstances is absolute proof that it has no identical connection with our real swine-plague.

The investigators of the government of the United States assert that its peculiar swine-plague is identical with the German, and mainly upon bacteriological resemblances. I freely admit that should Peters' assertions become proven these observers would have a strong case against me, but I place equally strong reliance that they have none upon the previously noted fact that in no other reported investigations in Germany have we mention of intestinal lesions with or without pneumonia in a single case of the Loeffler-Schütz disease, and also upon Schütz's conclusions upon the Danish swine-pest and the disease in England.

On the other hand, in all the practical experiences of the past forty years in this country among our farmers we have no record of a single pestiferous disease of a "wide-spread" character attacking cattle and hogs at the same time and under the same conditions.

Have we any such evidence with regard to the German Schweine-seuche?

Although not so exact as could be desired, we have some.

Bleisch and Fiedeler say that "the owner of the stable (in which the hogs they had examined had died of Schweine-seuche) placed fourteen calves therein, and that some of them died, which caused them to investigate whether the disease Schweine-seuche was transmissible to calves.

"In order to prove this they inoculated two calves with a bouillon culture of known virulence, the one subcutaneously with 1 ccm., the other in the right lung with ½ ccm. of the same.

"The first died six hours after the inoculation."—P. 429.

The same microorganism as those injected was found in all the organs, and controlled in the necessary manner.

The second calf was not seriously affected. Insignificant in extent as this evidence is, it points in support of my hypothesis and assertions.

1st. The identity between the Schweine-seuche and the Wilde-seuche.

2d. The non-existence of the Schweine-seuche in this country.

The case would be strengthened had Bleisch and Fiedeler had opportunity to examine one of the calves reported to have died by the owner, and made the necessary control experiments from the same.

Another point must not be overlooked, and which contradicts the assertion of the Government that the Swine-plague and the German Schweine-seuche are identical, is the immense difference in the results following subcutaneous inoculations of the respective germs directly in the lungs of healthy swine.

The Government admits that "in none of these (its) experiments was the disease reproduced," even though they injected as high as 5 ccms. of a culture "directly into the lungs," (Report, 1887.) The German investigators were positively successful with so small a dose of culture as one-third of a ccm., the animal dying in ten hours, while the Government swine lived "forty-one days" and were killed, having been seriously ill. The Germans also produced the same lesions in their inoculated swine as they found in those infected under natural conditions, and say: "Confirmatory also was the presence of grey-red hepatization in the lungs, which in nothing, not even in the bacteriological results, differed from the natural disease as seen in its earliest stages."—P. 438.

It is but common honesty to admit that the Government investigators do report having finally killed a hog by the injection of 9 cubic centimeters"!!! of culture into the lung, but what kind of a germ with any virulence in swine would not kill in such doses as that. Prof. Welsh also reports similar results following the injection of 8 ccms. into the right lung of a pig, of the same germ.

Such experiments as that are more contradictory than confirmatory as to any identity between the swine plague of the government and the German Schweine-seuche. On the other hand, all attempts on the part of the government investigators to produce the German Schweine-seuche by subcutaneous inocula-

tion have utterly failed. Prof. Welch does not mention any such experiments. On the contrary, we may find some reported by Loeffler and Schütz as to the Schweine-Seuche.

First, as to Loeffler, who says on July 5 (year not given) he injected two young swine in the skin of the belly and leg respectively. One of them was dead in the stable on the morning of July 7 (and this by subcutaneous inoculation). Enormous œdema of the skin, lungs, hypostatic, etc. The second swine was not seriously sick.

Schütz injected 2 ccm. of a bouillon culture under the thin cutis of the inside of the hind leg of two young swine on the 26th, at 5 P. M. One died twenty-four hours after the inoculation; the other died exactly forty-eight hours after inoculation.

On the 14th of July Schütz inoculated subcutaneously another hog with 1 ccm. of a bouillon culture. It died on the night of the 16th, about two and one half days.

On the 16th of June, at 11 A. M., Schütze injected 1 c.cm. of a bouillon culture into the lung of an old hog. It died on the night of the 18th, about two and one-half days.

Let us compare these results, following the subcutaneous and intrapulmonary injection of the Schweine-seuche germ, with some others reported by the government where less than 9 ccm. were used.

"Dec. 6, two pigs, Nos. 43 and 47, were inoculated in the thorax as already described (into the lung, with a hypodermic syringe having a needle about three inches long), No. 43 receiving 1½ ccm., and No. 47, 3 ccm. No. 47, inoculated Dec. 6, *killed* Dec. 11th,—five days. No. 43, inoculated Dec. 6, lived to Jan. 23,—forty-eight days.

There seems to be too vast a degree of difference between this government germ and that of the German disease, even with the amount injected vastly in favor of the bureaucratic organism, to warrant any very strong claims for identity between the two.

Pathobiological Laboratory, Chicago, Ill.,
Feb. 13, 1890.

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General Notes.

GEOLOGY AND PALEONTOLOGY.

Notes on the Dinosauria of the Laramie.—PTEROPELYX GRALLIPES gen. et. sp. nov. This dinosaur is represented in my collection by the greater part of the skeleton of an individual found by Mr. J. C. Isaac near Cow Island, Montana, on the upper Missouri, in 1876. I have, as yet, detected no part of the skull or teeth in the collection. The generic characters are seen especially in the pelvis, of which the right half is nearly completely preserved. The ilium is quite elongate and compressed, terminating in flat, narrow plates both fore and aft. The pubis is slender, and its shaft is very small and short, while its pectineal process is extremely long, and expanded distally in a vertical plane, reaching in the specimens anterior to the line of the anterior extremity of the ilium. The inferior border of the acetabulum is thin. The ischium is also very slender, and is coössified proximally with the pubis, and is thence in close contact with it for the rest of its length. The astragalus is not united with the tibia, and the latter has no facet for the fibula on its distal surface. The feet are robust and constructed like those of Hadrosaurus, and there is a fourth digit, which is much shorter than the others on the posterior foot. Long bones solid.

This genus differs from the known Agathaumidæ in the very different form of the ilium, which is hadrosauroid in form. From both Hadrosaurus and Diclonius it differs in the probably elongate anterior limbs, which are indicated by the very large pectineal processes, which resemble the pelvis of Crocodilus, while the pelvis and ischium are so slender as to be almost functionless. The animal was thus apparently quadrupedal. The absence of the fibular facet of the tibia distinguishes it from the *Diclonius mirabilis*, but this is apparently wanting in the *Hadrosaurus foulkei* Leidy. The genus Pteropelyx displays characters between the Hadrosauridæ and Agathaumidæ. The genus Cionodon Cope, which is principally known from teeth, remains to be compared with it, as well as Dysganus, which is also known only from teeth.

Char. specif. This reptile is about the size of the *Hadrosaurus foulkei* Leidy, as the measurements below given will indicate. The anterior process of the ilium is rather longer than the posterior, is more com-

pressed, and narrow vertically. It is perfectly flat in the vertical plane, and not rounded as in *Hadrosaurus foulkei*, and has some superficial longitudinal ridges. The superior border of the ilium is narrow, except where it expands into an external angle above the point of junction of the ischium. The borders of the acetabulum are not expanded as in the Agathaumidæ, and the acetabular border of the ischium is acute. The neural spines of the dorsal vertebræ are elongate, and some of them are so wide anteroposteriorly as to touch each other. The bones of the posterior leg are very long (see measurement of the fibula), and the fibula is very slender. The metatarsals are very robust, and the phalangeal faces have the usual concavity in the transverse section.

As compared with the *Diclonius mirabilis* this species is as tall, but less robust. The scapula is longer and more slender, especially in its proximal portion. The distal part of the tibia is less robust, as are also the metatarsals. The heads of the mts. 2–4 are not as much compressed as in *Diclonius mirabilis*.

MEASUREMENTS.

	MM.
Length of scapula,	850
Width at neck,	100
Width at blade,	195
Length of ilium,	1000
Length of anterior process of ilium,	450
Length of posterior process of ilium,	280
Depth of ilium at acetabulum (about),	200
Length of pectineal process from base,	385
Width of pectineal process distally,	250
Diameters distal end tibia, transverse,	250
Diameters distal end tibia, greatest fore and aft,	145
Diameters distal end mt. 3, transverse,	115
Diameters distal end mt. 3, fore and aft (oblique),	70
Length mt. 4,	135
Diameters distal end mt. 4, anteroposterior,	65
Diameters distal end mt. 4, transverse,	75
Length of fibula,	890

This is more slender than any of the Hadrosauridæ known, but yields to none of these in dimensions. Its posterior legs are much longer than those of the *Monoclonius crassus*.

DICLONIUS PENTAGONUS Cope. Proceedings Acad. Nat. Sciences, Philadelphia, 1876, p. Oct. A lower jaw closely resembling that of this

species has been figured by Marsh (*Amer. Jour. Sci. Arts*, 1889, p. 336), under the name of *Hadrosaurus breviceps*. The lower jaw is figured as the upper, and is printed upside-down on the page.

AGATHAUMIDÆ. It is now evident that the genus Polyonax Cope (Triceratops Marsh) had elongate frontal horns, a relatively short one on the nasal bones, while Monoclonius Cope (Ceratops Marsh) has shorter horns on the frontals, and an elongate one on the nasals. The three coösified cervical vertebræ which I described in 1876 (Proceedings Academy, Phila., October,) occupy a position below the posterior prolongation of the parietal bone in Monoclonius. This coössification is appropriate to the immovable condition of these vertebræ in the position mentioned. Marsh (*Amer. Jour. Sci. Arts*, 1890, Jan.) denies postacetabular pubes to the members of this family. I find them, however, in Monoclonius.—E. D. COPE, *March 5, 1890.*

MINERALOGY AND PETROGRAPHY.[1]

Petrographical News.—In a most excellent paper, so full of information as to defy any attempt to do it justice in these notes, Lemberg[2] has given the results of his experiments on the stability of many rock-forming minerals when treated with water at high temperatures, and their power of resistance when subjected to the influence of solutions of various salts. The object of the experiments was to determine the cause of the widespread existence of certain minerals like leucite and hauyne in effusive rocks, and their entire absence from intrusive rocks, and also to determine the conditions that gave rise to the properties of elæolite and orthoclase on the one hand, and to nepheline and sanidine on the other. The only conclusions that can be referred to in this place are those with reference to hauyne and leucite. The existence of the former mineral in effusive rocks is ascribed to the oxidizing effects of the oxygen of the atmosphere upon the sulphur compounds of these rocks, and the reactions set up between the solutions thus produced and the constituents of the rocks. The non-existence of this mineral in irruptive rocks is regarded as due to the protection from atmospheric oxygen which these rocks enjoyed as a

[1] Edited by Dr. W. S. Bayley, Colby University, Waterville, Me.

[2] *Zeits. d. deutschen geol. Gesell.*, XL., 1888, p. 625.

consequence of their mode of formation. Its absence from all effusives is the result of the comparatively small quantity of oxygen in the air of early geological ages. The absence of leucite from intrusive rocks is thought to be due to the fact that the mineral can separate from a magma only under low pressure. The great stability of elæolite and orthoclase as compared with nepheline and sanidine is supposed to be the consequence of their formation under great pressure. So many other conclusions of equal interest are indicated throughout the paper, that it will well repay reading by any one interested in chemical geology or in the study of altered phases of rock masses.——The eruptive rocks[3] west and south of Sarn, Caernarvonshire, Wales, comprise granites, gabbros, diorites and gneissic diorites, diabase, picrite and dolerite. The gabbros and diorites are intimately related, the gneissic varieties of the latter having been derived from the former by pressure alteration. In the diabases augite is found in idiomorphic crystals and in ophitic plates. The hornblende occurs, (1), as an original constituent, enclosing grains of augite; (2), as a secondary product surrounding augite cores; (3), as a zonal growth around augites with a corresponding orientation; and (4), as a secondary fringe around original hornblende crystals. ——Harker[4] describes from Mynydd Mawr, three miles west of Snowdon, a bluish-gray compact rock, with porphyritic black crystals, without idiomorphic outlines, and twinned crystals of feldspar. The groundmass of the rock is a fine grained mixture of quartz and orthoclase, in which are the above mentioned phenocrysts and small acicular colorless crystals, with a faint blue tint when their long axes are parallel to the vibration planes of the nicols. They have a high index of refraction and nearly parallel extinctions, and are arrayed in flow lines. The large black crystals are pleochroic in blue tints, and upon close examination are found to be riebeckite, to which species the small acicular crystals are thought also to belong.——Mr. Diller[5] has separated the mineral supposed to be anatase in the periodotite from Elliott Co., Ky., and has had it analysed. Its composition is found to correspond with that of perofskite.

Mineralogical News.—Prof. Clarke[6] objects to Tschermak's theory with respect to the composition of the micas, in that, of the four fundamental molecules assumed by this mineralogist as the basis of his theory, three of them are unknown in nature, and two are chemi-

[3] Harker, *Quart. Jour. Geol. Soc.*, 1888, p. 442.

[4] *Geol. Magazine*, May, 1888, p. 224.

[5] *Amer. Jour. Sci.*, March, 1889, p. 219.

[6] *Amer. Jour. Sci.*, November, 1889, p. 384.

cally improbable. Further, each belongs to a different type, and therefore would not be expected to be pseudomorphic. Clarke suggests that all of the true micas are isomophous combinations of derivatives of aluminium orthosilicate [$Al_4(SiO_4)_3$] and of the corresponding polysilicic compound [$Al_4(Si_3O_8)_3$]. The different micas are taken up seriatim, and it is shown how each may be regarded as a compound produced by the isomorphous mixture of derivatives of these. *Muscovite*, for instance, may be looked upon as $Al_3(SiO_4)_3KH_2$, in which one atom of Al has been replaced by potassium and hydrogen, and *lepidolite* as a mixture of $Al_3(SiO_4)_3KHLi$ and $Al(Si_3O_8)_3K_3Li_3(AlF_2)_3$. The members of the *clintonite* group are also regarded as related to the micas, and to have the general formula $R'_3{\equiv}SiO_4{-}Al{=}R''O_2$. The formulas suggested by Prof. Clarke certainly have the advantage over those of Tschermak as far as simplicity is concerned, but whether they will prove of more value in the discussion of the composition of the micas, it remains for further work to determine.——Among a few minerals[7] recently described from Brazil the following present some points of interest. *Zircon* from the sands of Rio Verdinho, near Caldas, Minas Geraes, shows on cleavages parallel to ∞ P two systems of striations, one parallel to the diagonal of the cross sections, and another nearly normal to the P face. Sections perpendicular to the optical axis are uniaxial in some parts, and in others show a biaxial figure, probably due to a very fine system of twinning lamellæ. Fine large *apatite* crystals from the red orthoclase of a coarse-grained gneiss from Pedreira de Sandade, near Rio Janeiro, resemble very closely the apatites of Renfrew, Canada. They are of various colors, and possess the rounded contours of the Canadian specimens. Green *fibrolite* from Diamantia owes its color to the inclusion of numerous needles of tourmaline.——Miers and Prior[8] have recently made a very thorough examination of *proustite* and *pyrargyrite*. Their article begins with an historical and critical review of the work previously done on these interesting minerals. It continues with a discussion of the morphological and physical properties of all the crystals in the possession of the British Museum, and a review of the work of former mineralogists. The paper concludes with the results of analyses of ten specimens of pyrargyrite and five of proustite, and is accompanied by a plate on which are represented twenty-eight figures of crystals. Their results may be briefly summed up as follows: (1), proustite and pyrargyrite are distinct species, the former with a rhombohedral

[7] Dom Pedro Augusto, *Min. und. Pet. Mitth.*, X., p. 451.

[8] *Zeits. für Kryst.*, XV., p. 129, and XIV., p. 113.

angle of 72° 12′, a sp. gr. of 5.57, and a cinnabar—red streak; the latter with 71° 22′ as the rhombohedral angle, a specific gravity of 5.85, and a purplish red streak. (2), Pyrargyrite twins parallel to ½R, R, ∞P2—½R, and oR, proustite parallel to ½R, R, oR and —½R. (3), Both minerals are rhombohedral, and none of the typical forms exist at the same time in both plus and minus positions. (4), Pyrargyrite is $3Ag_2S.Sb_2S_3$, with a small percentage of As, and $a:c = 1:.7892$; and proustite is $3Ag_2SAs_2S_3$, with occasionally a small amount of Sb, and $a:c. = 1:.8038$. Many new forms are described in pyrarygrite and a few in proustite.——Fine crystals of *gold* from the placers of the Senarka and the Kamenka rivers, Gouvernement Orenburg, Russia, are described by Jeremejew[8] in the *Goruyi Journal* for 1887. Combinations of ∞O∞, O, and other more complicated forms are beautifully twinned parallel to an octahedral face. Pseudomorphs of limonite after pyrite, anatase, rutile, and many other interesting minerals associated with the gold, are also carefully described and figured.——Molengraff[9] has contributed to the study of quartz an interesting article on the rounded faces on many crystals. Since these are nearly always covered with concavities of the shape of the etched figures characteristic of quartz, the author regards them as having been produced by natural etching. The effect of alkaline carbonates, hydrofluoric acid, and potassium hydroxide upon crystals has been studied, resulting in the discovery that alkaline carbonates at 125° quickly produce etched figures in such a way that the etched faces are rapidly rounded.——According to Valentin[10] the abnormal crystallographic development of certain *barite* crystals from the Kronthal, in Alsace, is also due to natural etching. Concavities occurring on P∞̄, oP, and ½ P∞̄ are identical with those produced by artificial means.——After discussing the analyses of *atacamite* that have been published within the past ninety years, together with new analyses published by himself, Darapsky[11] concludes that the substance called by this name is probably an isomorphous mixture of molecules varying within the limits $CuCl_2.3CuO.3H_2$, and $CuCl_2.4CuO.6OH_2O$, just as plagioclase is an isomorphous mixture of the albite and anorthite molecules. ——Having obtained a few large, pure crystals of *pseudobrookite* from Havredal, Bamle, Norway, Cederström[12] has analyzed them, and found

[8] Ref. *Zeits. für Kryst.*, XV., p. 526.

[9] Ib., 1888, XIV., p. 173.

[10] Ib., XV., 1889, p. 576.

[11] *Neues Jahrb. f. Min.*, etc., 1889, II., p. 1.

[12] *Zeits. f. Kryst.*, 1889, XVII., p. 13.3

their composition to be simpler than has been supposed. The figures obtained by him are: $Fe_2O_3=56.42\%$, $TiO_2=44.26\%$, corresponding to $Fe_4(TiO_4)_3$. The author thinks that *brookite* may be $Ti_4(TiO_4)_3$.——At the temperature of melting copper the mineral *cyanite*, according to Vernadsky,[13] loses its color, and its characteristic physical and optical properties, and assumes those of *sillimanite*. Hence it is regarded as a triclinic form of Al_2SiO_5, whose orthorhombic variety is the last-named mineral. The rocks in which cyanite is found (the crystalline schists) can therefore not have been formed at high temperatures where this mineral is an essential, original component.——Hamberg[14] has discovered well-developed crystals of *lead* in the iron and manganese mines of Harstig, at Pajsberg, Sweden. The silver-white crystals are imbedded with arsenates in calcite nests. They show the forms O, $\infty O\infty$, ∞O, $2O2$, $5O$, and $\infty O4$, and have a specific gravity of 11.37. The author explains the origin of the lead by supposing the reduction of lead compounds by arsenious acid in its oxidation to the arsenic form. Igelström[15] records the same mineral as occurring in thin plates and fine veins in an amorphous blood-red neotokite-like mineral, abundant at the manganese and iron mine Sjögrufvan, in the Parish Grytthyttan, Örebro, Sweden.——An analysis of a manganese ore from the Crimona mine, Augusta Co., Va., yielded Mr. Jarman:[16]

MnO	O	Fe_2O_3	CaO	NiO	CoO	K_2O	Na_2O	H_2O	Lers.
78.27	17.61	.62	.09	.22	.27	.18	.23	2.08	.29

a result which indicates a remarkably pure ore.——In an article on the minerals from the Tyrol, Cathrein[17] mentions the discovery of the two new planes— $\left[\frac{\infty O4}{2}\right]$ and $\left[\frac{4O2}{2}\right]$ on *pyrite*, and $\frac{7}{6}O$ on *pleonast* from Monzoni, and describes a pseudomorph of *quartz* after apophyllite from the Fassathal.——Pseudomorphs of *hematite*, after pyrite, found in the calcareous red slate of Torquay, England, are described by Solly.[18]——Mr. Yeates[19] describes a *copper* pseudomroph, after azurite, from Grant Co., New Mexico, as consisting of spongy copper, into which kaolin has been pressed.——A pseudo-

[13] *Bull. Soc. Franc. d. Min.*, XII., p. 447.

[14] *Zeits. f. Kryst.*, 1889, XVII., p. 253.

[15] *Neues. Jahrb. f. Min.*, etc., 1889, II., p. 19.

[16] *Amer. Chem. Jour.*, XI., p. 39.

[17] *Min. u. Petrog, Mitth.*, 1889, X., p. 395.

[18] *Min. Magazine*, 1889, May, p. 183.

[19] *Amer. Jour. Sci.*, Nov. 1889, p. 405.

mroph of *pyrolusite* after manganite, has been obtained by Gorgeu[20] upon heating crystals of the latter mineral to a temperature of about 300°.——Dick[21] finds the kaolin from near Porth-yr-hwch, Anglesey, to be monoclinic, with $a : b : c = .5748 : 1 : 4.7267$, and the face $\infty P\breve{\infty}$, ∞P, P, oP prominent. Its specific gravity is 2.62, and composition: $SiO_2 = 46.53$, $Al_2O_3 = 38.93$, $H_2O = 14.54$.——Des Cloizeaux[22] pronounces the mazapilite of Koenig to be orthorhombic.

BOTANY.

On the Hypophyllous, Epiphyllous, or Amphigenous Habits of Uredineæ.—Whether the *Uredineæ* are hypophyllous, epiphyllous, or amphigenous is, I think, determined largely by the character of the leaf. On those leaves which have stomata on the lower surface only, they are with few exceptions hypophyllous. They seem to normally infect the lower surface of the leaf, and spread in age, or in later stages, to the upper.

Taking Dr. Burrill's pamphlet on the *Uredineæ* as a basis for estimation, we may draw some interesting conclusions. Of the some one hundred and thirty species there given only *three* are epiphyllous, and these furthermore are frequently amphigenous. By far the greater number of species are hypophyllous only, while still a large number are amphigenous (about 48 amphigenous to 74 hypophyllous). Of the forty-six species and varieties of *Æcidium* all are hypophyllous but three, and these are amphigenous. This fact indicates that the teleutospores and their sporidia, when they germinate in the spring, must, in almost every case, enter the tissue of the host-plant through some stoma on the lower surface of the leaf, irrespective of whether the stomata occur on the upper surface also or not; and that here, in the looser soft tissue of the lower surface, more sheltered from the sun than if on the upper surface, the mycelium grows, giving rise to the first stage, the *Æcidium*, which, springing likely from the older, more compact hyphæ, bursts through the nearest and least firm, compact lower surface. In *Uredo*, the middle stage, the examination of one

[20] *Bull. Soc. Franc. d. Min.*, XI., p. 196.

[21] *Min. Magazine*, May, 1888, p. 15.

[22] *Bull. Soc. Franc. d. Min.*, XII., p. 441.

hundred species taken in order, in Saccarda's Sylloge Fungorum, shows fifty-five to be hypophyllous, thirty amphigenous, and fifteen epiphyllous, the proportion of amphigenous species having slightly increased. We also notice here a decided increase in epiphyllous species. This may likely be accounted for from its being an intermediate stage, springing from the germination of the æcidiaspores. These, produced, as we have seen, with but few exceptions, on the lower surface of the leaf, would tend to drop their spores on the upper surface of the leaves below them, thus perhaps giving rise to this more frequent epiphyllous character of the uredo.

In the teleutospore stage of species in Burrill's Uredineæ (Puccinia, Uromyces, etc.), the amphigenous species predominate by a small majority.

The increasing frequency of amphigenous position from the first stage to the last thus seems to be due to the older and more extensive growth of the fungus in the tissue of the host. Its continued growth likely injures and somewhat softens the upper more firm palisade tissue, thus allowing a breaking out above.—HERBERT A. WEBBER, *Lincoln, Neb.*

ZOOLOGY.

Gastrotricha.—Carl Zelinka, of Gratz, has recently monographed the Gastrotricha of the world (*Zeitschr. wiss. Zool.*, XLIX., Pt. 2, 1889). These are small aquatic forms the position of which is very uncertain. They are defined by Zelinka as follows: Without retractile ciliated wheels on the anterior end; with two ciliated bands extending the length of the ventral surface; with two coiled water-vascular canals each bearing a rod-like ciliated funnel and terminating separately on the ventral surface; a simple brain, not completely separate from the ectoderm; simple muscle cells; paired ovaries; fore-gut muscular, Nematode-like, without jaws, with straight glandless mid-gut and pear-shaped hind-gut, rectum and dorsal anus; with primary body cavity. With these points Zelinka is inclined to place them near the Rotifiers. He describes the anatomy, dealing especially with the skin and its appendages (scales, hairs, etc.), water-vascular system, nervous system, sense organs (tactile hairs, eye spots?), muscular system, alimentary tract, and genital organs. In all, thirty-two species are enumerated. The following key serves to separate the genera:

With caudal fork;	1.
Without caudal fork;	2.
1. With bristles;	3.
1. Without bristles;	4.
2. Head with tentacles, hinder end slightly lobed;	*Gossea.*
2. Head without tentacles, hinder end rounded;	*Dasydytis.*
3. Caudal fork simple;	*Chætonotus.*
3. Caudal fork dichotomous;	*Chætura.*
4. Skin smooth;	*Ichthydium.*
4. Skin with scales or hooks;	*Lepidoderma.*

AMERICAN SPECIES.

Ichthydium podura (O. F. Muller).
Ichthydium sulcatum (Stokes).
Lepidoderma squamatum (Dujardin).
= *Chæt. squammatus*, Stokes.
= *Chæt. tessellatus* Stokes.
= *Chæt. loricatus* Stokes.
Lepidoderma rhomboides (Stokes).
Lepidoderma concinnum (Stokes.)
Chætonotus maximus Ehr.
= *Chæt. gracilis* Stokes.
Chætonotus similis Zelinka.
= *Chæt. maximus* Stokes.
Chætonotus formosus Stokes.
Chætonotus acanthodus Stokes.
Chætonotus brevispinosus Zelinka.
= *Chæt. lanis* Fernald and Stokes.
Chætonotus acanthophorus Stokes.
Chætonotus spinulosus Stokes.
enormis Stokes.
longispinosus Stokes.
spinifer Stokes.
Dasydytes saltitans Stokes.
goniathrix Stokes.
Gossea antennigera (Gosse).

Homologies within the Group of Echinoderms.—Richard Semon (*Morphol. Jahrbuch*, 1889) discusses the homologies which occur within the group of Echinoderms. He thinks that in their broader features the alimentary canal, enterocœle, water-vascular system and nervous system are to be regarded as truly homologous throughout the

group,—that is that they have had a common origin and descent (are homophyletic). Other structures which appear very similar, and have often been regarded as homologous, are but analogous, and are to be regarded as homoplastic. Besides these there are others which are intermediate in position, being partly homophyletic and partly homoplastic. Among these are to be enumerated the musculature, a part of the nervous and water-vascular systems of the Holothurians. Semon also refers to the unanimity of results arrived at by him in his previous work on the Synaptidæ (*Jenaische Zeitschrift*, 1888), and those of the brothers Sarasin in their studies of the Echinotheridæ, both concluding that the Holothurians represent the stem form within the group of Echinoderms. Semon does not agree with Newmayr in assigning this position to the Cystidians.

The Ontogeny of Pelvic and Shoulder Girdles.—R. Wiedersheim has studied the development of the girdles in *Scyllium canicula*, *Mustelus lævis*, *Pristiurus melanostomus*, *Torpedo ocellata*, *Thymallus vulgaris*, *Triton helveticus*, *T. alpestris*, *Siredon pisciformis*, *Salamandra maculata*, *Alytes obstetricans*, *Rana temporaria*, *R. esculenta*, *Lacerta agilis*, *Chelone midas*, and *Crocodilus biporcatus*. His genera conclusions (*Ant. Anz.* IV.) are as follows:

1. The pelvic and shoulder girdles are strictly homologous; both possess the same Anlage.

2. Both are phylogenetically and ontogenetically later formations than the free limbs.

3. The free limb is to be regarded as the mechanical principle under the formative influence of which a yoking apparatus or fixation point must arise in the body wall. These structures are the shoulder and pelvic girdles.

4. In the Selachii, and apparently in all fishes, the primitive continuity of the girdle and appendage persists into the cartilaginous condition. From the Amphibia on this continuity can only be recognized in the precartilage condition. The cartilaginous Anlage are separate in each region, though there may be in the Amphibia a secondary (transitory or permanent) fusion of the free-extremities with the girdles.

5. From the Amphibia on there is a marked tendency for the separate elements of the girdles to appear separate in the cartilaginous stage. The fusion is secondary, and earlier authors have been in error when describing a single hyaline cartilage blastoma.

6. The pars ischio-pubica and the pars scapularis are phyletically the oldest portions in their respective girdles.

7. In the Fishes and Dipnoi (also in Ichthyosaurus) the pars iliaca does not reach the vertebræ.

8. The pars iliaca first reaches the vertebræ when the vertebrate in question wholly or partially gives up its swimming existence, and its hinder limbs, from being swimming organs, begin to serve as supports. From this moment the weight of the body in the pubic region must be prevented from sinking, and the strong processes of the ventral bones must provide a support for the body weight on the free extremities. A similar support is formed in part by the pectoral fins.

9. A fusion of the partes ischio-pubicæ of both sides to form an unpaired lamina ischio-pubica as in Dipnoi, Ichthyoidea and Derotrema, recurs now and then in the larval stages of the salamanders; *i.e.*, at a time when the tail gives the locomotor impulse.

10. The old question whether the fishes and Amphibia possess only a pars ischiada or also a pars pubica, is to be decided by these later views. The pars pubica is not a structure first appearing in the Reptilia, but is characteristic of the fish and amphibian pelvis. The certainty of this lies first in the relations of the nervus obterratorius, and second in the relationships shown by the embryonic chelonian and crocodile pelvis. In these lie the key for the interpretation of the urodele pelvis, which is repeated ontogenetically in this reptile.

11. Not only is the pelvis not composed of one or more pairs of ventral ribs, but the parts of the pelvis formerly compared by me with such (pars iliaca) are actually the last phylogenetically to appear.

The Segments of the Vertebrate Head.—Van Wighe has recently attacked this problem in the light of the facts afforded by Amphioxus. He finds (*Anat. Anzeiger*, IV., p. 558) that in the adult the gill slits extend back to or even beyond the 27th myotome, while in early specimens the liver empties in the 13th myotome. He also thinks that still earlier specimens would show the liver two segments farther in front. Now if the liver be taken to indicate the line between the head-gut, and that of the body, it follows that the number of segments which in Amphioxus corresponds to the head of the Craniatas is probably nine and cannot be much greater. Amphioxus also affords no difficulty to the view derived from the ontogeny of the sharks that the vagus is a complex of two dorsal nerves. He concludes that the skull never consists of metamerically arranged cartilaginous elements; only in the occipital region behind the vagus is there a

possibility of separate cartilaginous neural arches. The parietal musculature and the peripheral nervous system (except the three higher sense nerves) are segmented in the head as in the body region. The number of head myotomes is in general nine, and in those Craniata which have no hypoglossus as a cranial nerve (unless the same and its myotome is aborted), is smaller. To each body and head segment belong a dorsal and a ventral nerve. These are primitively separate, as is shown by Amphioxus and the embryos of the Craniata. In case the ventral nerve is lacking, the corresponding myotome is lacking. The vagus is a complex of two nerves. There is no ground for the view that the Craniata ever possessed more than eight gill pouches (apart from one possibly aborted in the hyoid arch). This number is reached in Heptanchus, Chlamydoselachus, the embryos of the Petromyzons and probably in the Carboniferous genus Xenacanthus.

Horny Teeth in the Marsupialia.—Teche, in studying the skull of a young Myrmecobius (*Anat. Anzeiger*, Aug., '89) finds that a bony ridge runs parallel on either side to the alveolar process of the upper jaw, while in older skulls it exhibits a retrograde development. In sections of the mucous membrane covering this ridge, he found several clusters of tooth-like structures, which upon examination with a higher power were resolved into a large number of rows of teeth, each containing several (as many as 8) horny teeth, nested within each other. In older Myrmecobii no traces of the teeth were found.

On the Genus Clevelandia.—In the NATURALIST for Jan., '90, page 85, occurs the statement that "Clevelandia is reduced to synonomy (by Jenkins and Evermann, Proc. U. S. Nat. Mus., 1888), as was done some time ago in this journal."

The genus Clevelandia was based on a specimen in the collections of the Museum of Comparative Zoölogy, and the diagnosis published in the Proceedings of the Calif. Acad. Sci., second series, Vol. I., Jan., '88.

At the time the diagnosis was written we could not, on account of Museum regulations, examine the skull of the type of Clevelandia. Later, Mr. Evermann sent us specimens of his *Gillichthys guaymasiæ*, requesting us to re-examine the type of Clevelandia. We did so, examining the skull, which was found to be smooth and regularly convex in transverse profile, without ridges or crests. The skull of Gillichthys is depressed, with a strong median crest. These notes were sent to Mr. Evermann. This was in the early part of the summer of '88.

Nevertheless, Jenkins and Evermann, in their rafinesque paper, quoted above, which was issued Jan. 5th, 1889, do not mention this fact, but state that "an examination of the material at hand leads us to believe that the newly proposed genus Clevelandia was based upon characters that are not of generic value, and cannot therefore stand. In Gillichthys the number of dorsal spines has been invariably given as six. The fact that the number of dorsal spines in Clevelandia and in our specimens, which *will agree otherwise with*[1] Gillichthys as limited by Cooper, are four and five respectively, would seem to indicate that the limits of the genus Gillichthys should be extended. This is evidently preferable to basing a new genus upon so slight a character as a difference of one or two dorsal spines." This statement occurs under the head of *G. guaymasiæ*.

These statements of Jenkins and Evermann deserve some comment. The "material at hand" (1) was the types of guaymasiæ, including a prepared skull; (2) a series of skeletons prepared by me in the collections of the Indiana University, where Jenkins and Evermann's hastily prepared paper was written; (3) the notes furnished Mr. Evermann on the types of Clevelandia. Of this material Jenkins and Evermann have seen fit to ignore all but the types of *guaymasiæ* (a description of the skull of this species is conveniently omitted.)

The second sentence quoted above was copied from Jordan and Eigenmann's Review of the Gobiidæ, and may stand. The third sentence needs modification. The type of Clevelandia was described by Steindacher, Ichthyol. Beitr., VIII., 27, as *Gobiosoma longipinne* with four to six dorsal spines, so it is hardly probable that we should have based the new genus of "dorsal spines," as Jenkins and Evermann have supposed.

We have been in hopes for some time of obtaining duplicates of the types of the gobies described by Jenkins and Evermann, in order to determine their generic relations, and figure them for a paper on the gobies of the West coast.

It is perhaps well to state that we have found *Clevelandia longipinne* to be the commonest fish in San Diego Bay. *Gillichthys y cauda* J. & E., is also found in San Diego Bay. To the diagnosis given by Jenkins and Evermann should be added "shoulder with dermal flaps." The statement, "teeth in *a single* series on premaxillaries and mandible," etc., should read "teeth *in broad bands*," etc.

A revision of the diagnosis of the genus Clevelandia is in press.

[1] The italics are ours.

The genera of West Coast gobies may be distinguished as follows:

a. Eyes normal, functional throughout life, body scaly.
  b. Shoulders without dermal flaps.
    c. Skull depressed.
      d. Skull without distinct median keel, abruptly widened behind eye; scales permanently ctenoid; *Gobius.*
      dd. Skull with a strong median keel, not abruptly widened behind the eye, triangular behind; scales cycloid. (Skull and scales in young as in Gobies); *Gillichthys.*
    cc. Skull strongly convex in transverse profile, perfectly smooth, without ridges or crests; scales minute, cycloid, imbedded; *Clevelandia.*
  bb. Shoulders with one or two small dermal flaps; skull resembling that of the adult Gillichthys;[2] *Lepidogobius.*
aa. Eyes mere vestiges, functional only in the young skull; greatly modified, brain case quadrate; body naked; *Zyphlogobius.*

The intention of reducing to synonymy all species described by other authors is undoubtedly laudable as long as it does not lead an author to shut his eyes to facts, or even wilfully to ignore them.—C. H. EIGENMANN.

Ribs of Salamandra.—Iversen has been studying the skeletons of *Salamandra atra* and *S. maculosa*, and finds (*Anat. Anz.* IV.) on the second vertebræ a strong rib-like outgrowth, which distally expands into a large kidney-shaped plate of hyaline cartilage, which is connected with the shoulder-girdle by fibrous tissue. He recognizes the same element in the "scapula" of the extinct Stegocephali; and if this view be true, the so-called clavicula is the true scapula.

Reptiles and Batrachians from the Caymans and Bahamas.—Mr. S. W. Garman contributes to the Bulletin of the Essex Institute, Vol. XX., an account of these forms, collected for the Museum of Comparative Zoölogy by Mr. C. J. Maynard. Seventeen species are enumerated, of which the following are new: *Sphærodactylus argivus*, from Cayman Brac; *S. corticolus* and *S. decoratus*, from Rum Key; *Anolis luteosignifer*, from Cayman Brac and Little Cayman; *A.*

[2] *Gillichthys y cauda* probably is a genus distinct from Lepidogobius, but as we have no specimens of the type of Lepidogobius, it perhaps should not be named at present.

maynardii and *A. leucophæus*, from Little Cayman; *Alsophis fuscicauda*, from Cayman Brac; *Ameiva maynardii*, from Inagua; and *Sphærodactylus asper*, from Andros Island. The paper is more valuable from the fact that it contains many notes upon habits, color, etc., made by Mr. Maynard.

The Mammalian Corpus.—Baur shows (*Anat. Anz.* IV.) that in the turtle foot there are two centralia, and claims that if this be true the scaphoid of the mammalian carpus is not a radiale but a centrale, while the "radial sesamoid bone" is a true radiale. He also claims that the "heptadactyly" of Wiedersheim and others has no existence in the mammalian extremity. The prehallux is the radiale, while the pisiform is not the representative of a digit, but a structure which has developed more and more from the Batrachia, where it is unossified.

Zoological News.—Protozoa.—Dr. Joseph Leidy (Proc. Acad. Nat. Sci., Philadelphia, 1889) describes the following species of Gregarinida: *Gregarina philica*, from the proventriculus of *Nyctobates pennsylvanicus*; *G. actinotus*, from the proventriculus of *Scolopocryplops sexspinosus*; *G. megacephala*, from *Scutigera forceps*; and *G. microcephala*, from *Hoplocephala bicornis*. The first named species was remarkable in conjugation as the individuals united by the head, the bodies lying side by side.

Mr. G. E. Mainland calls attention (*Jour. Quecket Club*, IV.) to the fact that in Actinosphærium the polariscope reveals "thousands of minute but highly refractive particles vibrating and scintillating throughout the entire sarcode."

Echinoderms.—J. E. Ives presents a study of the color variations of *Ophiura panamensis* and *O. teres*. In the first-named species specimens from the northern localities are the darkest. It does not appear that either species is more variable than our northern brittle stars.

Vermes.—*Brachidnus quadratus* is a new Rotifer described by C. Rousselet (*Journ. Quecket Club*, IV.), from Epping Forest, England.

The second part of the work of M. le Baron St. Joseph upon the Polycheta of the coast of Dinard occupies about 200 pages of the *Annales des Sciences Naturelles*, 1888, and contains descriptions of 23 new species and one new genus. The work is prefaced with an account of the habits of the Aphroditaceæ, which often have ectoparasites, and are themselves at times epizoarians or commensæ of other annelids or of echinoderms.

Mollusca.—H. A. Pilsbry describes the following new molluscs (Proc. Acad. Nat. Science, Philadelphia, 1889): *Holospira elizabethæ*, Guerrero, Mexico; *Pœcilozonites reinianus* var. *goodei*, Bermudas; *Bythinella æquicostata*, Florida; *Amnicola peracuta*, Texas; *Sphærium singleyi*, Texas. He also gives notes on *Microphysa hypalepta*, *Zonites dallianus*, *Z. singleyanus*, *Pœcilozonites bermudensis*, and *Hydrobia monroënsis*. In the same volume W. D. Hartman describes ten new species of shells from the New Hebrides.

Crustacea.—Dr. Leidy describes from a specimen of *Leptocephalus* taken at Beach Haven, N. J., a copepod under the name *Chalimus tenuis*.

Arachnids.—Dr. Leidy records under the generic name Solpuga (Proc. Acad. Nat. Sciences, Philadelphia, 1889) *Galeodes cubæ*, as taken in Florida.

Mr. J. E. Ives has found (Proc. Acad. Nat. Sciences, Philadelphia, 1889) a large number of *Linguatulina diesingii* encysted in the great omentum of a Sooty Mangabey, *Cercocebus fuliginosus*, which died in the Zoological Gardens, at Philadelphia.

Dr. Geo. Marx (Proc. Acad. Nat. Sciences, Philadelphia, 1889) catalogues twelve species of spiders collected by Mr. Heilprin in the Bermudas. The spider fauna is cosmopolitan, only four being restricted to the island. *Lycosa atlantica* is the only new species.

Myriapoda.—C. H. Bollman catalogues (Proc. Phila. Acad., 1889) four species of myriapods collected by Mr. Heilprin in the Bermudas. *Spirobolus heilprini* is regarded as new.

Vertebrata.—Dr. John T. Bowen describes in the *Anatomischer Anzeiger*, Bd. IV., the epitrichial layer in the human epidermis, which was briefly mentioned by Dr. Minot in a former volume of the AMERICAN NATURALIST. Dr. Bowen's conclusions are (1) that the outermost epidermal cells of young embryos form a distinct histological layer; (2) that this layer disappears by the sixth month over most portions of the body; (3) that in certain places, as in the region of the nail, this layer undergoes a keratosis, and forms a part of the stratum corneum; (4) that there are good reasons for regarding this layer as homologous with the epitrichium of animals; (5) that the nail is a modified portion of the stratum lucidum, and becomes exposed by the loss of the epitrichial layer. Whether the cells overlying the stratum lucidum

in all parts are homologous with the epitrichium must be decided by further investigations.

Ostroumoff makes the following homologies between the embryos of Lizards and Selachians: In both an embryonic anus, which closes and later opens to form the permanent anus; the allantois anlage with the post-anal gut; the neurenteric canal; the primitive groove, with the split between the caudal lobes; the primitive streak with the caudal lobes.

Prof. Bardeleben has discovered traces of a prepollex and a prehallux in certain Reptilia, and also records the existence of a two-segmented prepollex bearing a nail in Pedetes, and a two-segmented pisiform in Bathyergus.

Fishes.—Mr. S. Garman describes (Bulletin Essex Inst., XX.) a new Murænoid eel from the Marshall Islands (*Rhinomuræna quæsita*) which is remarkable in the fact that the anterior nostrils are prolonged into tubes, each terminating in a broad flap. The snout is also acute, and the lower jaw possesses three barbels. The length is thirty-three inches, of which two-thirds is occupied by the tail.

Mr. F. C. Test describes and figures (Bulletin Essex Inst., XXI.) certain problematical organs in the skin of the Californian fish Porichthys which are supposed to be phosphorescent in character. Each consists of a lens, reflector, and nerve supply, but none are like any form described by Ussow or Von Lendenfeld. The organs in question are interesting from the fact that they occur in a shore fish, while all other phosphorescent fishes are abyssal in habitat.

Batrachia.—Perenyi thinks, from observations upon Bombinator (*Anat. Anz.* IV., 587), that the notochord is not as has been supposed a derivative of strictly entodermal tissue, but is to be regarded as formed by the lips of the blastopore, tissue which is neither ecto- or entodermal. He regards, farther, the mesoderm as but the duplication of the lower layer cells.

Reptiles.—Junglöw (*Anatom. Anzeiger*, IV.), contrary to Hoffman, states that the heart in *Lacerta agilis* has a double or paired origin, the halves being about the same size, and uniting very soon.

Aves.—M. K. Marage (*Ann. des. Soc. Nat. Zoöl.*) describes the anatomy of the sympathetic nerves in birds, with reference especially to the connections which exist between them and the spinal nerves. He di-

vides his work into four portions, treating respectively of the cephalic, the cervical, the thoracic, and the abdominal nerves, and his work in each of these departments comprises a historic resumé, the structure to be found in the domestic duck, and a comparison of that of the latter with that of other birds. His conclusions are that it is at the level of the thorax that the sympathetic receives most nervous fibres from the spinal cord; that above the thorax there is a single sympathetic trunk, with numerous ganglia terminating in the superior cervical ganglion, while below the thoracic region the sympathetic consists of a single nervous thread, bifurcating only when it encounters an obstacle; some branches put this part in relation with the spinal cord. The arrangement is analogous to that which obtains in reptiles.

Dr. R. W. Shufeldt concludes from a study of the skulls of a large series of forms that the families of Passerine birds should be arranged as follows: Tyrannidæ, Laniidæ, Ampelidæ, Hirundinidæ, Alaudidæ, Certhiidæ, Viveonidæ, Motacillidæ, Sylviidæ, Cœrebidæ, Mniotiltidæ, Cenclidæ, Troglodytidæ, Turdidæ, Paridæ, Tanagridæ, Fringillidæ, Icteridæ, Sturnidæ, Corvidæ, the latter being placed at the top of the scale largely upon the extremely uncertain grounds of psychology.

Dr. Shufeldt has also described the pterytography of the burrowing owl, Ipeotyti, and contributed some other facts regarding the same animal. Both papers are in the *Journal of Morphology* (Vol. III).

Miss Julia B. Platt has been studying the primitive metamerism in the chick. Her first problem was the solution of, Which is the first protovertebra to be formed? and she concludes that the first incision separates the second from the third protovertebra, the second incision completes the third muscle plate, and that later there is found in advance of the first incision one complete protovertebra and a second partial one. She also has studied the primitive segmentation of the brain, where she differs somewhat from other observers. In the chick, according to her observations, there are seven neuromeres found in front of the first protovertebra, and from the *first* of these are developed Pros-thalam and Mesencephalon; the *second* gives rise to the cerebellum, and the other five to the medulla. There are also other points made upon the origin of the nerves, especially the fifth, and Miss Platt is inclined to regard the neuromeres of the medulla as homologous with those of the rest of the cord.

Mammals.—The domestic cat serves as the basis of several studies by Dr. T. B. Stowell. In the *Proceedings of the American Philosophical Society* he continues his studies of the cranial nerves, tracing out

the finer branches of the glosso-pharyngeal, accessory, and hypoglossal nerves. Neither paper is capable of abstract, while the adoption of the Wilderian adjectives and adverbs renders them somewhat pedantic and obscure.

Dr. Frederick Tuckerman has recently published several articles upon the taste organs of mammals. In the *Anatomischer Anzieger* occur descriptions of these organs in *Putorius vison*, (Vol. III., p. 941), *Arctomys monax*, (Vol. IV., p. 334), *Perameles nasuta*, (Vol. IV., p. 441). In the latter he finds lateral taste areas overlooked by Poulton. In the *American Journal of Science* for October, 1889, he describes the organs in the common hare. In the *Journal of Anatomy* occur accounts of the taste organs in *Vulpes vulgaris* (Vol. III., p. 201).

Leboucq (*Anat. Anz.*, IV.) finds that on the digits of the fins of fœtal Sirenia and Cetacea there are evident traces of claw-forming epithelium. On the dorsal surface of each digit there is an insinking of the epidermis like that which precedes the formation of nails and claws in other mammalia, but no claw is formed by it.

EMBRYOLOGY.

The Development of Micrometrus aggregatus, one of the Viviparous Surf-perches.—At a recent meeting of the San Diego (Cal.) Medical Society, Dr. C. H. Eigenmann presented the results of his further studies upon the early viviparous development of the very minute ova of *Micrometrus aggregatus*. The differences in the modes of segmentation were pointed out, and a comparison of the embryonic membranes of the different major types of amniotic vertebrates was made. The effect of the loss of a large food-yolk, as illustrated upon comparing the egg of a mammal and a bird, was shown to resemble a similar loss of food-yolk in the eggs of Micrometrus as compared with other large-yolked oviparous fish eggs. [The eggs of *Micrometrus aggregatus* are the smallest fish ova yet described, measuring only a little over 1-140th of an inch, or less than those of most mammalia, thus showing the profound influence of viviparity in causing a diminution in the size of ova.]

The following are Dr. Eigenmann's most recent observations:—

The average pelagic fish egg has a diameter of about 1 mm.; only

a very minute portion of which segments and takes part in the formation of the embryo. The egg is deposited by the mother in the water, where it lies or swims unprotected. As the tail of the young fish is formed it begins to move, first feebly and then vigorously, until the membrane surrounding the egg is burst and the young fish swims out. At the time of hatching the intestinal tract is still very rudimentary, the food, until the intestines are more fully developed, being supplied by the large mass of yolk stored in the egg. The tail is at this time quite free from the yolk, and it is usually fringed by a broad, thin membrane which serves as a fin.

The development of Micrometrus differs from the usual mode in some very essential characters, as this form belongs to a family of viviparous fishes almost exclusively confined to the west coast of North America. All the members of this family give birth to their young in an advanced stage. Micrometrus has gone further in this peculiar line of development than the other members of the family with the exception of *Abeona minima*. The ovary of the former consists of a spindle-shaped tube, from the dorsal wall of which are suspended six broad, thin sheets of membrane, in which are scattered comparatively few ova. At the time the eggs are ripe the ovary is no thicker than a goose quill, and the oviferous tissues are folded upon themselves. With the growth of the embryos the walls of the ovary become greatly distended, the oviferous sheets unfolding at the same time.

To follow the development of a single egg: While still in the tissues in which it was developed it measures .24 mm. in diameter, is opaque, and contains a germinal vesicle. At the time of ripening the egg contents shrink to less than half their original volume, the germinal vesicle disappears, and the protoplasm of the ovum is separated from the yolk or food material, the whole contents of the egg measuring at the end of this shrinking but .18 mm. in diameter. By comparing this diameter with that of the average fish egg, it will be noticed that the volume of this is more than 100 times less than that of the ordinary fish egg. This reduction is not merely mechanical; it is due to the non-formation of yolk, which has been reduced to a small particle lying at one side of the comparatively large mass of protoplasm, forming the germinal mass, which segments at once after impregnation.

This non-formation of food yolk may be explained in the following manner; taking it for granted that the embryo will be supplied with all the necessary food by the mother. The ovary of the typical fish passes through a state of physiological rest and a state of physiological

activity. The resting stage begins immediately after the spawning; the active stage begins a few months before spawning and culminates at spawning. During the resting period the eggs contained in the ovary do not perceptibly increase in size, while during the active stage they double their volumes many times.

In Micrometrus the active period begins when the eggs are ripe, and culminates at the time the young are set free. In other words, the eggs become ripe when in ordinary fishes they only begin their most active growth. Now the yolk of normal fish eggs is found chiefly during the time of rapid growth; maturation of the egg of Micrometrus being hastened several months, and occurring at the beginning of active growth, it is matured with but little yolk.

In the young eggs of Micrometrus there lies a small nucleus exterior to the germinal vesicle. This nucleus increases in size, and in the ripe egg lies directly at the vegetative pole of the egg. A similar structure is seen in Abeona.

At or near the time of the shrinking of the egg it is freed from the ovarian follicle in which it was developed. By the shrinking of the egg a large chamber is formed between it and the membrane surrounding it. About this time fertilization probably takes place.

The spermatozoa deserve more than a passing notice. They are composed of a rod-shaped head and a long vibratile tail. Large numbers of them are found in the ovary, and the conditions for their continual activity being favorable they live in the ovary several weeks, very probably until they are digested by the young fish. They seem to increase in activity with their stay in the ovary. Their rapid motion keeps the fluid secreted by the ovary in constant circulation. This circulation is undoubtedly taken advantage of by the young, it bringing a large amount of oxygenated mucus in contact with them. If the spermatozoa were not present other arrangements for the circulation of the mucus would have to be provided, or the embryos and early larvæ would undoubtedly be asphyxiated.

The spermatozoa seem to have a triple function. First, the normal one of fertilizing the egg; second, to circulate the mucus and thereby to ærate the embryo; third, to act as pabulum to the larvæ as soon as the digestive tract is sufficiently developed.

The segmentation as far as observed is normal. It is apparent, however, that *inherited tendencies only keep the egg from segmenting totally*. The stages from the completion of segmentation to hatching are not yet understood.

The embryo at hatching is in a very rudimentary condition. The tail is not yet free from the yolk and is in contact with the head. The tissues over the base of the yolk lengthen and the embryo begins to straighten itself. The tail does not begin to grow out until some time later. Several days are undoubtedly consumed after hatching in reaching the equivalent stage of oviparous fishes at the time of hatching.

The hastening in hatching is due to the absorption by the embryo of food supplied by the ovary. The embryo thus soon fills the cavity left between the egg and the membrane at maturation, and the membrane then bursts. The hatching process is therefore decidedly different from the hatching of oviparous fishes.

If the newly-hatched oviparous fish is compared with the corresponding stage in Micrometrus another ancestral trait will be discovered in the latter. While the yolk in the latter is minute as compared with that of the former, the *yolksack is just as large.* The yolk fills but a very small portion of it; almost all the yolksack is occupied by the enormous pericardial chamber through which the thin tubular heart passes upward and forward.

The development of the whole family of fishes of which Micrometrus is a representative (the Ditremidæ) is characterized by the hypertrophy of the hind gut, first pointed out by Ryder. This is already well developed at hatching, and at the time Kupffer's vesicle appears it very probably extends considerable beyond the point where the latter is situated. In all stages until the last this hind gut protrudes greatly from the ventral profile.

Yolk absorption is not completed until quite late in the development, that is, not until the embryo has reached a stage homologous with the corresponding stage of oviparous fishes at the time of the completion of yolk absorption. That the yolk is not sufficient to account for a tithe of the growth of the embryo during this time goes without saying. The delay in the total absorption of the yolk is simply another trait inherited from oviparous ancestors.

The food absorption is of considerable interest. The earliest absorption is undoubtedly similar to the preplacental absorption of food by the embryos of placentalian mammals. At the time the embryo has developed a tail and circulation, and before the mouth is open, the first gill slit is open, and *a continuous stream of mucus mixed with spermatozoa enters the intestinal tract at this point, and passes out of the anus apparently unchanged.*

With the opening of the mouth villi appear in the hind gut. Food secreted by the ovary is now taken in through the mouth, and can be

seen to fill the anterior intestine and extend into the posterior intestine as a solid rod, usually terminating in a knob. It is very probable that the primitive absorption does not cease with the opening of the mouth, and that even after the villi are formed it is carried on by the now highly vascular fins. The larvae are at no time connected with the ovary.

Next to the feeding, the aeration is of great importance. The ovarian structures are well supplied with blood vessels, and the mucus contained in the ovary is undoubtedly oxygenated by osmosis, while spermatozoa keeps the mucus in circulation. There is, then, nothing further to explain as respects the early stages, the conditions being similar to those obtaining in pelagic eggs. With the growth of the fins they become highly vascular, the blood vessels occupying much more space than the remaining structures of the fin membrane. The fins also are several times as large as they are in the adult, and the tips of the membranes are continued beyond the ends of the rays. The fins therefore offer a very large surface in which osmotic action may take place. A similar network of capillaries is formed over the whole surface of the body. At this time also the ovary has become greatly distended, and the inner oviferous sheets have become unfolded. The fins can therefore lie directly against the vascular structure of the ovary, and osmosis takes place directly between the blood of the mother and the blood of the young.

About twelve young are born at one time. Seven or eight months after the young are born they are sexually mature, and contain embryos.—C. H. EIGENMANN, *San Diego, Cal., Feb 8, 1890.*

On a Brood of Larval Amphiuma.—During the last two or three years the writer has been endeavoring to obtain larval Amphiumidæ. Recently, Prof. Edmond Souchon, of Tulane University, New Orleans, La., has been enabled to obtain some advanced larvæ for me, in the egg, which he has very generously placed at my disposal. As already described by Hay, the eggs are joined together by a narrow cord formed of the same material as the egg-coverings. Most of the embryos had escaped from the eggs when they reached me, and, owing to the long journey they had made, were dead, though they were in a fairly good condition for study after proper treatment with Kleinenberg's fluid.

What has surprised me is the variation in size of these embryos. Though all have evidently only just escaped from the egg, and have not had any opportunity to feed, there is a marked diversity in their

length and size. The smallest specimens measure 38 mm., while the largest measure 54 mm., and are correspondingly robust as compared with the smaller individuals. All have apparently absorbed the yolk, since there is no external evidence of a yolk sack in any case. Whether this indicates that the egg varies in size when laid, cannot, of course, be determined until further opportunity is afforded to obtain still earlier stages.

In those specimens which are best preserved, the skin presents certain features which do not appear to have been noticed by others, viz.: the presence of a system of lateral line organs, which differ somewhat in arrangement from those of other urodelous batrachia. There are three rows of end organs on the sides, as in other Urodeles. Of these the uppermost one is faint, and lies close to the middle one. The median one extends along the entire length of the sides, and over the sides of the tail. The lowermost row is most widely separated from its fellows of the same side, and extends only from the axilla to the groin, as usual in other forms.

With respect to the terminal or end organs on the head, they are much less conspicuously developed than in other Urodeles, and there appear to be no distinct rows of them externally along the course of the hyoid and branchial arches, as in *Amblystoma*.

The smallest as well as the largest individuals have the limbs developed, and all have three toes, so that the limbs are evidently as fully developed as they will ever be at the time of hatching. In this respect *Amphiuma* differs not only from all other limb-bearing Urodeles, but from the *Anura* as well. The fore and hind limbs also seem to be developed almost or quite synchronously, a feature which is unusual also.

There are three short, slightly plumose branchiæ set in an oblique row on either side of the back part of the head. There is nothing to indicate that they differ very widely from those of the larvæ of *Amblystoma* in their histological structure.

The general color of the smaller individuals is darker than that of the larger ones. The smaller specimens are blackish brown, the largest ones somewhat paler and also lighter on the under side of the body. Some specimens have a very narrow colorless stripe running along the median line of the belly.—JOHN A. RYDER.

The Acquisition and Loss of Food-Yolk, and Origin of the Calcareous Egg-shell.—The discovery of a form of *Peripatus* with a minute egg, without yolk, and a sort of placental development,

as well as the discovery made by Mr. Eigenmann that the ovum of the viviparous surf-perches is almost completely yolkless, resulting in a reduction in volume of the whole ovum to such an extent as to be paralleled in size only by the ova of the more prolific lower forms and those of mammals, goes far toward giving us the requisite data for a reinvestigation of the causes leading to the diminution and loss of the food-yolk, after the latter had once been acquired, as must have been the case in *Peripatus*, *Micrometrus*, and the *Mammalia*.

The ova of primitive types were almost wholly without yolk. The surplus nutriment of such forms was at once elaborated into a great number of small ova, so that the chances of survival were augmented by the great fertility thus attained by a species, which was without the means for affording its young any protection.

If, however, owing to some such circumstance as an unusual abundance of food, the individual ova of the same species would either tend to be multiplied in number in the ovary, or the individual ova would tend to increase in size, it might even happen that they would become the depositories in which surplus oils or other hydrocarbons would be stored up, as actually happens in the case of fish eggs, thus leading through a common histological process, such as that witnessed in the formation of ordinary adipose tissue, to the evolution of an egg capable of floating at the surface of the water as happens in the case of pelagic fish ova. Such a result doubtless would contribute powerfully toward favoring the survival of a species provided with such floating ova, which we thus perceive may have arisen as a consequence of the action of natural causes, not having specifically as their end the salvation of the species, but rather the disposition of a surplus of material elaborated by the female organism and sent to the ovary.

If, further, the parent female organism became more highly developed, more intelligent, circumspect, and alert, the ability to obtain nutriment would be increased, but with this increase of powers the ovary becomes, as a matter of fact, reduced in dimensions, and there is further nothing to prevent one's assuming that the most favorably situated ova would receive the most nutriment and reach the largest size. Diminution of the ovary would tend to limit the number of ova to be nourished, and thus increase their size. If, furthermore, the female parent became circumspect, the tendency would be to retain the eggs in the oviduct until a favorable opportunity was offered for their deposit. If such retention were prolonged, as occurs in reptiles, for a considerable time, there would first of all tend to be deposited albuminous or plasmic secondary deposits, or secondary membranes, or even

a calcareous shell would tend to be formed as the result of the normal secretory activity of the oviduct, inherited from still lower forms. In this way alone is it possible to conceive of the evolution of the egg-shell of such forms of reptiles and birds. The secretory activity thus diverted from depositing surplus nutriment in the ovary would inevitably tend to diminish the fertility of the individual female, and starve the remaining ova in the ovary, unless active feeding went on during and after the period of the retention of the already formed ova in the oviduct.

Now suppose a still further advance on this process, as a result of which not only the egg but the embryo is developed and nourished in the reproductive passages. Any further ova which are now detached from the ovary after fertilization has occurred under these new circumstances, and as a result of copulation, cannot be fertilized, but must be resorbed. The growing embryo in the oviduct is also now diverting the whole of the spare nutriment to itself from the ovary, and thus tending to starve any other young ova which it may still contain. The consequence is that the physiological conditions established by either the retention of ova for an unusual period, or the viviparous development of the embryo through its retention in the oviduct, would directly tend to bring about, first of all, a diminution of fertility, and secondly, as a consequence of viviparity, check the future production of ova or germs for the time being. The result is obviously one which would tend to be self-perpetuating, and at the same time advantageous to the species. For, while the fertility of the species is diminished, the chances of survival are increased, so that the loss suffered in one direction is compensated in another.

Maturation of the ova in the ovary, and their dehiscence in in forms in which the ova are small, is simultaneous for very large numbers. On the other hand, where a large amount of yolk is added, besides an abundance of albumen and one or more secondary egg-envelopes, this simultaneity gives place to a sequence in the maturation of the ova, either singly, one after the other, or a sequence which is expressed in the serial arrangement of the ova in a row or rows in one or both oviducts. The effect of the delay of the ova in the oviducal passages, where they acquire additional material, must be such as to tend to put not only an end to simultaneity of maturation of ova in the ovary, but also from that very circumstance to diminish the absolute fertility of the species as determined by the number of ova matured. That the ovary, as well as testes, have been reduced in length and volume in the higher forms, is certain from the fact discov-

ered by Nagel that the germinal epithelium in the mammalian embryo is much greater in extent than is required for the rudiments of either ovaries or testes. Similar facts are known respecting the development of the ovaries and testes of other forms. In the human female at puberty there are potentially 72,000 ova in the ovaries, yet of these only about 400 can by any possible chance ever become mature in a lifetime, while an average fertile marriage would, instead of increasing, actually reduce the number to 350. This is due to the interference of the process of gestation. So pronounced is this interference in its physiological effects that it leads to the development of a marked difference between the corpus luteum formed in the ovary in the pregnant and that formed during the non-pregnant condition.

To sum up, the secondary processes of ova-gestation, viviparity, and utero-gestation have tended to diminish the fertility of a species as measured by the whole number of ova produced in a lifetime; but at the same time a great gain was made in the strength, vigor, and opportunity for survival of the offspring. Ova-gestation, all forms of viviparity, except the parthenogenetic, and utero-gestation, are probably the consequences, in the first place, of the acquisition of the ability to effect a fertile union or copulation of the sexes, the impulse toward which probably came originally from the male, where the sexes were distinct.

These processes have also tended to direct nutriment from the ova and ovary to be built up into the embryo in other ways, thus tending to intensify the alecithal or yolkless condition of the other eggs remaining in the ovary; or where a brief ovo-gestation only occurs, as in birds, reptiles, and monotremes, the surplus nutriment has been concentrated upon the few serially matured ova, thus increasing the actual volume of the latter rather than diminishing it. If, however, prolonged utero-gestation supervenes, the opposite effect must follow, and nutriment be continually diverted from the ovary to the uterus, and thus tend to diminish the size of the ova remaining in the ovary. The subsequent period of lactation would tend to prolong this diversion of surplus nutriment from the ovary in mammals.

The fertility of the marsupialia is much greater than that of other mammalia, and the eggs, as was to have been expected from the shorter period of gestation, are also much larger. I have myself removed twenty-two ripe ova from the uteri of a single female of the common Virginia opossum. Other facts with which I have become familiar in a study of the gestation of mice and rats, tend to show that an embryo may develop to a certain extent and then undergo histo-

lytic disintegration and total resorption within the uterine coruna, even after an advanced stage of development has been reached. Dr. Arthur V. Meigs has shown me a series of fine preparations showing such a process, and one of my pupils, Mr. Edward Bancroft, has prepared a series of sections from the uterus of a mouse showing much earlier abortive stages of the embryo, which also indicate that absorption takes place subsequently.

These facts indicate that the fertility of an individual may be reduced by processes of absorption of the whole embryo within the uterus. These phenomena may be associated with the resorption of ova in the ovary, as described by Ruge, to which I can add that such a process of resorption of ova is a common occurrence at the end of the spawning season in the ovary of common sturgeon. These facts further indicate how complex the physiological factors are which determine the size and number of the ova matured by a species during a single season. They also go far toward showing how important it is to consider the effect of the acquisition of certain habits upon the result, such as those of copulation, nidification, stealth, and care in hiding the ova, the latter often being retained for a greater or lesser period of time, until it is convenient or safe to deposit them.

Finally, it may be affirmed that the solution of the question of relative fertility of a species, the acquisition and loss of a food-yolk, is completely beyond the reach of the current "*Ding an Sich*" morphological method. It is also clear that the neglect to study the reproductive habits of a species in connection with its physiological and morphological characteristics is to be condemned. Unless the contrary method is followed, there is no possible clue to the origin of the calcareous egg-shell in the ova of oviparous land vertebrates. There is, moreover, otherwise no hope of connecting the phenomena of ova-gestation with those of utero-gestation; the one must have preceded the other, otherwise the remarkable fact that no well-authenticated case of placentation has ever been made out where there is a large amount of yolk present, also loses its obvious significance, while the development of an outer layer of nutritive epiblast in mammals (trophoblast of Hubrecht, *Deckschicht* of other authors) loses its adaptive import and becomes a mere morphological "*Ding an Sich*," to be shelved and labeled like a rare *bon mot* in the mental cabinet of the specialist.

It may be added, in conclusion, that the *membrana putaminis* of eggs of birds and reptiles is a reticular but cuticular membrane, which is to be regarded as the homologue of the keratose cuticular secondary

oviducal membranes of still lower forms,[1] and that it would tend to take up calcareous matters in the same way as similar membranes in other parts of the body of a vertebrate. (See my paper "A Physiological Theory of the Calcification of the Skeleton," *Proc. Am. Philo. Soc.*, Vol. XXVI., 1889.)—JOHN A. RYDER.

PHYSIOLOGY.

THE American Physiological Society held its annual meeting for 1889 on December 27th and 28th at the College of Physicians and Surgeons in New York. H. P. Bowditch, J. G. Curtis, H. H. Donaldson, H. N. Martin, and S. W. Mitchell were elected as the Council for 1889–1890. The following communications were presented:

1. J. G. Curtis, Methods of demonstrating to a large class: *a*. The automatism of the heart of the turtle; *b*. The contraction of the diaphragm of the dog; *c*. The beating of the heart of the calf in opened thorax.

2. W. P. Lombard, The effect of fatigue on voluntary muscle contraction.

3. R. H. Chittenden, *a*. The influence of alcohol on proteid metabolism; *b*. Some observations on the relative formation of albumose and peptone in gastric digestion.

4. S. J. Meltzer, On the self-regulation of respiration.

5. H. N. Martin, The normal respiratory movements of the frog.

6. G. T. Kemp, *a*. Exhibition of a new chronograph clock; *b*. Exhibition of photographs illustrating the coagulation of blood.

On the Origin of the Central Nervous System of Vertebrates.[1]—Gaskell reviews the work of Leydig and other workers on the homologies between the arthropod and vertebrate nervous systems, and considers the resemblances between these systems, both from an anatomical and a physiological point of view, too strong to be disregarded. As to the brain, all researches indicate the anatomical separation of the brain of the crustacean into three parts, which correspond in relative position to the fore-brain, the mid-brain with the

[1] In which chalazæ are also developed, as in the egg of the common skate of our Eastern coast.

[1] *Brain*, July, 1889.

optic thalami, and the hind-brain of vertebrates. In the spinal cord we see another parallelism, for this structure in vertebrates closely resembles the ventral chain of ganglia in crustaceans.

One difficulty stood in the way of further work on the homology between the nervous system of vertebrates and the arthropod nervous system, *i.e.*, the question of the invertebrate alimentary canal. Gaskell's theory that this canal is still existent in the vertebrate nervous system removes the difficulty. The remains of the old alimentary canal are found in the non-nervous tube which is mixed up with the nervous system proper. "This alimentary canal was of the type of the crustacean canal, a large cephalic stomach, and a straight simple intestine opening by means of an anus. The remains of the non-nervous cephalic stomach are well seen in the cephalic region of the nervous system in the shape of non-nervous epithelial structures, which are so freely found here as part of the walls of the central tube, and which by being thrown into folds form on the dorsal side the choroid plexus, on the ventral side the saccus vasculosus. Remains of the mouth and œsophagus are found as a folded down tube forming the infundibulum with the lobi infundibuli. In this way an explanation is given of non-nervous structures found in connection with the nervous tube of vertebrates." Now, if Gaskell's theory be true, we ought to find in connection with the canal of the vertebrate nervous system in the cranial region, some trace of the so-called liver of crustaceans, a large and important organ opening by a duct into the pyloric end of the cephalic stomach. In man nervous material entirely fills the cranial cavity, while in the fish the brain lies in a case, the greater part of which is filled by a jelly-like material. Gaskell does not consider this jelly a packing material, but the remains of some pre-existing organ, and this organ he thinks to be the so-called liver. In the study of Ammocœtes he finds this material to be arranged in a definite mass composed of glandular looking cells, and in a hilus formed in the mass he finds the remains of a tube passing from the commencement of the fourth ventricle to the surface. The spot where it leaves the fourth ventricle is in the region of the *ganglion interpeduncular*e, which according to Ahlborn contains within itself the remains of a diverticulum from the central cavity of the nervous system. The duct opens into the central cavity at the posterior limit of the fourth ventricle,—*i.e.*, into the pyloric end of the cephalic stomach.

Gaskell discusses several structures whose functions are unknown. The interpretation of the hypophysis is so closely bound up with the question as to whether it is a paired organ or not, that he disregards it.

The epiphysis is the remains of an eye which is not vesicular, and can therefore be derived from the crustacean eye. The substantia nigra, as pointed out in a previous paper, represents the remains of the stomatogastric ganglia which are found on the œsophageal commissure. In the ganglion habenulæ the author sees the remains of a very prominent part of the supra-œsophageal ganglion. The taenia thalami, "which form a system of fibres passing from the ganglion habenulæ into the cerebral hemispheres, represent the original connection between two parts of the supra-œsophageal ganglion. Meynert's bundle represents the connection between the middle segment and some part of the sub-œsophageal ganglion, probably the ganglion interpeduncular."

Finally, this theory explains the formation of the cerebral vesicles in the embryo.—L. G.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

(Continued from page 847.)

Some physiological traits of the solid-stemmed grasses, and especially of Indian Corn (maize).—30 min.—By F. L. Stewart.

On the genus Eleocharis in America.—10 min.—By N. L. Britton.

On the tropical distribution of certain sedges.—15 min.—By N. L. Britton.

Alimentary apparatus of the Honey Bee.—13 min.—By A. J. Cook.

A suggestion concerning scientific work.—15 min.—By Wm. A. Dudley.

A newly-imported Elm insect.—15 min.—By L. O. Howard.

Notes on seedlings of Elymus virginicus.—5 min.—By W. J. Beal.

Notes on Bird's-eye Maple.—15 min.—By W. J. Beal.

On the assumption of floral characters by axial growths in Andromeda catesbæi.—5 min.—By Thomas Meehan.

On the significance of dioecism as illustrated by Pycnanthemum.—10 min.—By Thomas Meehan.

On the higher division of the Pelecypoda.—40 min.—By W. H. Dall.

On the flora of New Jersey.—20 min.—By N. L. Britton.

The House-fly: Hæmatobia cornicula Will.—10 min.—By John B. Smith.

Reserve food substances in twigs.—10 min.—By Byron D. Halsted.

Notes upon stamens of Solanaceæ.—7 min.—By Byron D. Halsted.

The relation between temperature and the number of vertebrae in fishes.—10 min.—By D. S. Jordan.

The new botanical laboratory of Barnard College.—5 min.—By N L. Britton.

A bacterial disease of Indian Corn.—15 min.—By T. J. Burrill.

A bacterial disease of Carnations.—15 min.—By J. C. Arthur.

Revision of the United States species of Fuirena.—10 min.—By Fred. V. Coville.

On the intentional importation of parasites and natural enemies of Insects injurious to vegetation.—15 min.—By C. V. Riley.

Preliminary report on reproductive characteristics of the Hydroid Eudendrium.–Sp.—5 min.—Chas. W. Hargitt.

Grasses of Roan Mountain.—8 min.—By F. Lamson Scribner.

An observation on Calaminth anuttalli.—5 min.—By David F. Day.

Fermentation of Ensilage.—15 min.—By T. J. Burrill.

The Palæontological evidence for the transmission of acquired characters.—10 min.—By Henry F. Osborn.

Modern teaching appliances in Biology.—30 min.—R. Ramsey Wright.

On a convenient method of subjecting living cells to coloring agents.—15 min.—By George L. Goodale.

Notes on the local distribution of some birds.—5 min.—By A. W. Butler.

A new departure was made in Section F, by the passage of a resolution to have appointed a special subject for discussion at the meeting in 1890. The subject chosen was the "Geographical Distribution of Plants," and the persons selected, and the topics for each, were as follows:

Sereno Watson—"The Relations of the Floras of Mexico and the United States."

John Macoun—"The Ligneous Plants of Canada."

C. S. Sargent—"The Ligneous Plants of the Rocky Mountains."

John M. Coulter—"The Umbelliferæ."

L. M. Underwood—"The Hepaticæ."

Byron D. Halsted—"American Weeds."

N. L. Britton—"General Distribution of North American Plants."

SECTION H.

Notes on Aboriginal Fire-making.—10 min.—By Walter Hough.

Shinto, the religion of the Japanese.—30 min.—By Romyn Hitchcock.

Siouan terms for "Mysterious" and "Serpent."—5 min.—By J. Owen Dorsey.

Gens and Sub-gens as expressed in four Siouan languages.—5 min.—By J. Owen Dorsey.

Some Principles of Evidence relating to the Antiquity of Man.—25 min.—By W. J. McGee.

On the Evolution of Ornament: the American lesson.—25 min.—By W. H. Holmes.

Aboriginal Mounds of North Dakota.—30 min.—By Henry Montgomery.

The Iroquois White Dog Feast.—23 min.—By W. M. Beauchamp.

The Mission and Mission Indians of California.—40 min.—By Henry W. Henshaw.

Evidences of the successors of Palæolithic Man in the Delaware River Valley.—25 min.—By C. C. Abbott.

The Winnipeg Mound Region.—15 min.—By George Bryce.

Artificial Languages.—25 min.—By David R. Keys.

New Linguistic Family in California.—15 min.—By H. Henshaw.

The Parsee Flowers of Simea.—10 min.—By Mrs. R. Hitchcock.

Seega, an Egyptian game.—5 min.—By H. C. Bolton.

Onondaga Shamanie Masks.—20 min.—By De Cost Smith.

Gold Ornament from Florida.—30 min.—By A. E. Douglas.

The Phonetic Alphabet of the Winnebago Indians.—20 min.—By Miss Alice C. Fletcher.

The Middlewiwin, or Grand Medicine Society of the Ojibwoo.—45 min.—By W. J. Hoffman.

Algonkin Onomalotology.—35 min.—By A. F. Chamberlain.

Indian Personal Names.—30 min.—By J. O. Dorsey.

Huron—Iroquois of the St. Lawrence and Lake Region.—20 min.—By D. Wilson.

Gesture Language of Blackfoot Indians.—15 min.—J. McLean.

The African in Canada.—40 min.—By J. C. Hamilton.

Indian Burial in New York.—23 min.—By W. M. Beauchamp.

Portrait Pipe from Central America.—15 min.—By A. E. Douglas.

Government of the Six Nations.—40 min.—By O-ji-ja-tek-ha.

Ancient Japanese Tombs and Burial Grounds.—30 min.—Romyn Hitchcock.

Result of Explorations about the Serpent Mound of Adams Co., Ohio.—20 min.—By F. W. Putnam.

Aboriginal Monuments of North Dakota.—30 min.—By Henry Montgomery.

Little Falls Quartzes.—20 min.—By Franc E. Babbitt.

A Mississagua Legend.—15 min.—By A. F. Chamberlain.

Places of Gentes in Siouan Camping Circles.—20 min.—By J. O. Dorsey.

Onomatopes, Interjections, etc.—45 min.—By J. O. Dorsey.

Ancient Pit Dwellers of Yezo.—15 min.—By R. Hitchcock.

Steatite Ornaments from the Susquehanna River.—5 min.—By Atreus Warner.

Notes on the Eskimo of Cape Prince of Wales, Hudson's Strait.—15 min.—By F. F. Payne.

Contents of Children's Minds.—10 min.—By Harlan H. Ballard.

The Accads.—30 min.—By Virginia H. Bowers.

SECTION I.

The Fall in the Rate of Interest.—15 min.—By Geo. Iles.

What shall we do about Silver?—40 min.—S. Dana Horton.

Economic Notes regarding Luxury.—40 min.—A. G. Warner.

Food moulds the Race.—15 min.—Mrs. Nellie S. Kedsie.

Certain Aspects of Agriculture in the Arid Regions.—20 min.—J. Richards Dodge.

Development of Trade Channels.—30 min.—Henry C. Taylor.

Statistical Results of the Examination of Eyesight of five thousand Public School Children.—20 min.—Dr. G. Stirling Ryerson.

The Abolition of Slavery in Upper Canada.—20 min.—Wm. Houston.

The Science of Economic Engineering.—40 min.—Gustav Lindenthall.

Industrial Education.—15 min.—By Laura Osborn Talbot.

National Interest in Material Resources.—30 min.—By B. E. Fernow.

The Sociologic position of Protection and Free Trade.—40 min.—By Lester F. Ward.

Agricultural Experiment Stations.—20 min.—By W. O. Atwater.

A Plan for a Census of Fisheries.—15 min.—Chas. W. Smiley.

Inutility of the Desert Land Act.—12 min.—J. R. Dodge.

Scientific and Economic means of Protecting Life by Signal Lights.—30 min.—William Franklin Corton.

How shall we Protect our Forests?—20 min.—By R. W. Phipps.

The scientific application of heat to the cooking of food.—30 min—By Edward Atkinson.

Relation of Manual Training to Body and Mind.—40 min.—By C M. Woodward.

Concluding remarks upon the Economic and Sociologic relations of Canada and the United States.—15 min.—By Chas. S. Hill.

It was decided to hold the next meeting of the Association at Indianapolis, on the third Wednesday in August. The officers elected were as follows:

President, George L. Goodale.

Section A.—S. C. Chandler, Vice-President; Wooster W. Beman, Secretary.

Section B.—Cleveland Abbe, Vice-President; W. Le Conte Stevens, Secretary.

Section C.—R. B. Warder, Vice-President; W. A. Noyes, Secretary.

Section D.—James E. Denton, Vice-President; M. E. Cooley, Secretary.

Section E.—John C. Brauner, Vice-President; Samuel Calvin, Secretary.

Section F.—C. S. Minot, Vice-President; John M. Coulter, Secretary.

Section H.—Frank Baker, Vice-President; Joseph Jastrow, Secretary.

Section I.—J. Richards Dodge, Vice-President; S. Dana Horton, Secretary.

Permanent Secretary, F. W. Putnam.

General Secretary, H. C. Bolton.

Secretary of the Council, James London.

Treasurer, William Lilly.

Reported by Prof. Jos. F. James.